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PARTICULATE EFFLUENT STUDY
PHOEBUS 2A--EP-IV and EP-V

by
Technical Support
Environmental Surveillance
Southwestern Radiological Health Laboratory

Department of Health, Education and Welfare
Public Health Service
Bureau of Radiological Health
Consumer Protection and Environmental Health Service

June 1969

This surveillance performed under a Memorandum of
Understanding (No. SF 54 373)
for the
U. S. ATOMIC ENERGY COMMISSION

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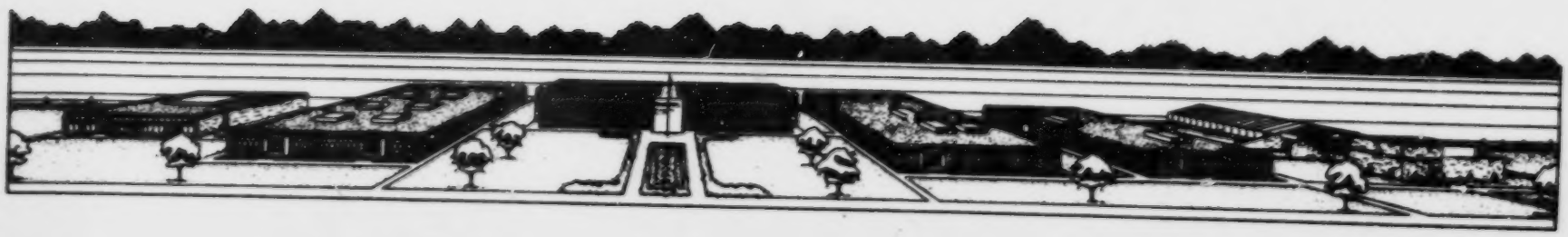

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ABSTRACT

The Phoebus 2A Experimental Plans IV and V were full-power nuclear reactor operations conducted as part of Project Rover.

Experimental Plan IV was conducted on June 26, 1968 and Plan V was conducted on July 18, 1968. Both tests were at the Nuclear Rocket Development Station, Jackass Flats, Nevada.

This report, covering large particles of high activity, includes particle deposition concentration at various distances; and gross physical characteristics, chemical composition, and gross and specific radioactivity of these particles.

Survey results indicated wide spread deposition for Plan IV with no defined hotline. Plan V survey results indicated the major deposition between 13° and 21° from Test Cell C.

The particles were porous and fragile and had a metallic black appearance. Sizes ranged from eight to 200 μm on Plan IV and seven to 163 μm on Plan V. The use of a latex spray reduced the shattering of particles during collection and separation.

The chemical composition of the particles was primarily uranium oxides. Fall velocity was determined in free air and liquid.

Gross activity of the particles was 10^{7} - 10^{11} fissions on both runs. Alpha activity was not determined because of the method of mounting the sample on glass slides with collodion. The primary radioisotopes found by gamma spectroscopy were those of Sr, Zr, Ru, I, Ba, Mo, and Ce.

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PARTICULATE EFFLUENT STUDY
PHOEBUS 2A EP-IV and EP-V

I. INTRODUCTION

The Phoebus 2A reactor engine Experimental Plans (EP's) IV and V were conducted on June 26 and July 18, 1968, as part of Project Rover; Los Alamos Scientific Laboratory (LASL). The experiments were conducted at Test Cell C, Nuclear Rocket Development Station (NRDS), Jackass Flats, Nevada. The power integrals for the plans are listed in Table 1.

TABLE 1

Power Integrals for Phoebus 2A*

EP-IV	4.6×10^6 Mw-sec
EP-V	2.5×10^6 Mw-sec

*Mw-sec = Megawatt-seconds (thermal)

This report contains the results of work performed by the National Center for Radiological Health at the Southwestern Radiological Health Laboratory (SWRHL) as outlined in the "Project Proposal for Reactor Effluent Studies - Particulate", August 1, 1967.

II. STUDY OBJECTIVES

The objectives presented in the Project Proposal that were accomplished in this study were the determination of:

1. Deposition concentration (particles per m^2) profile of particles both downwind and normal to the downwind axis.
2. Line of maximum deposition.
3. Physical, chemical, and radiometric characteristics of the radioactive particulate material collected.
4. Particle size versus distance.

III. FIELD ASSAY

A. Methods of Collection

Sampling routes were pre-established at approximately 15, 25, 40, 50, and 110 miles from Test Cell C, along existing roads. The distances between sampling locations and areas surveyed at each location are listed in Table 2. Specific instructions listed in Appendix A were given to each sampling team.

TABLE 2

Arc Data for Sampling*

ARC MILES FROM TEST CELL C	AREA SURVEYED (m^2)	NUMBER OF LOCATIONS (along the arc) EP-IV	EP-V	DISTANCE BETWEEN LOCATIONS (mi)
15	30	59	23	0.5
25	30	43	24	0.5
40	50	22		1
50	50		17	1
110	100	19		1

*Definition of terms on Page 24.

B. Field Results - EP-IV

Figure 1 shows the area surveyed along with particle concentration at each location. The results of the particle survey for EP-IV are presented in Table A-1. The table gives azimuth and distance of the location from Test Cell C, total particles found at a location and the particle concentration. Although the major effort was exerted between 30° and 113° from Test Cell C, a search was conducted on Highway 95 (147° to 164°) because aerial data showed a portion of the cloud passed over that area. No particles were found along Highway 95.

The change in average deposition concentration with distance is shown in Figure 2. Curve A illustrates the ratio of the total number

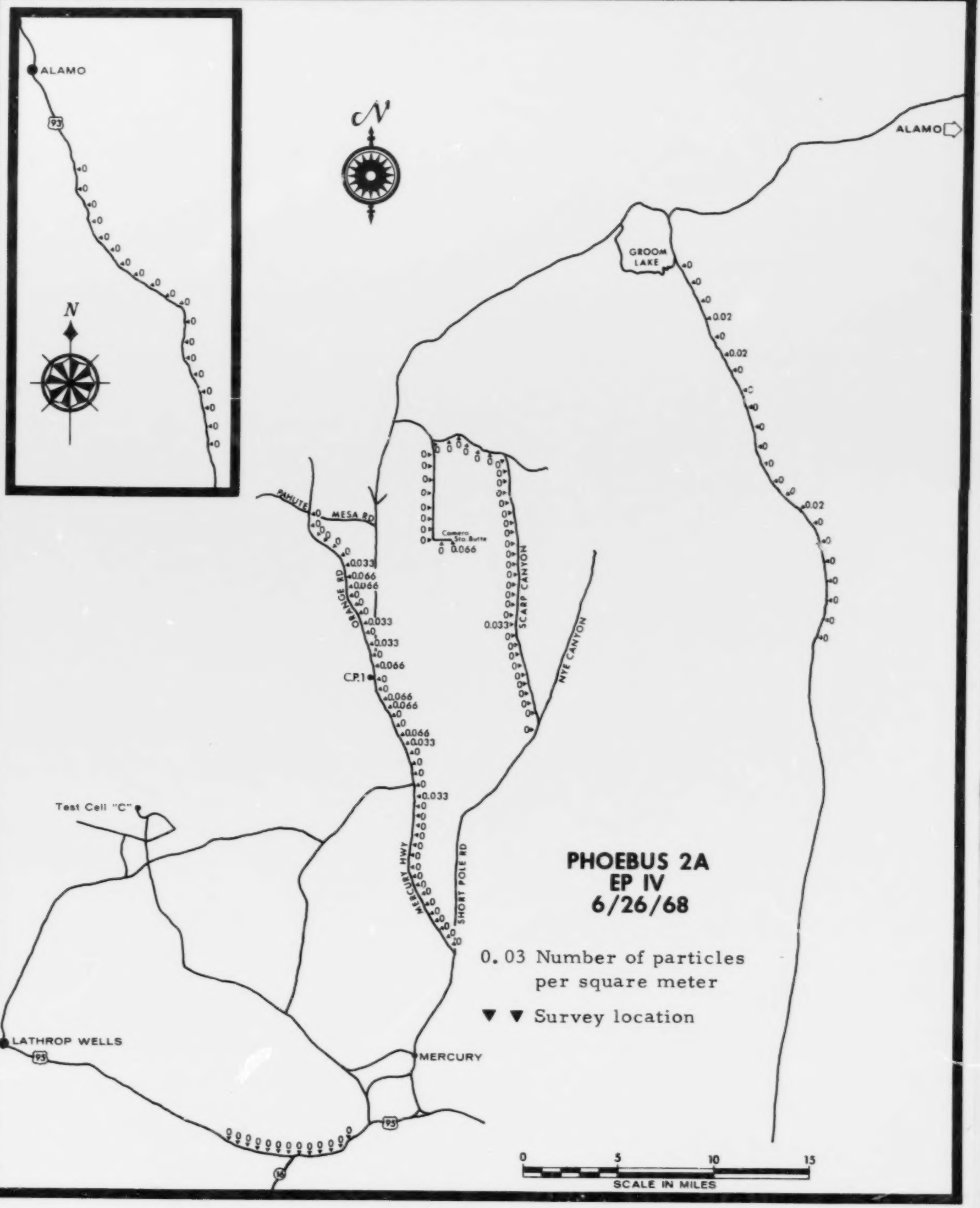

Figure 1. Sampling locations and particle concentrations - EP-IV.

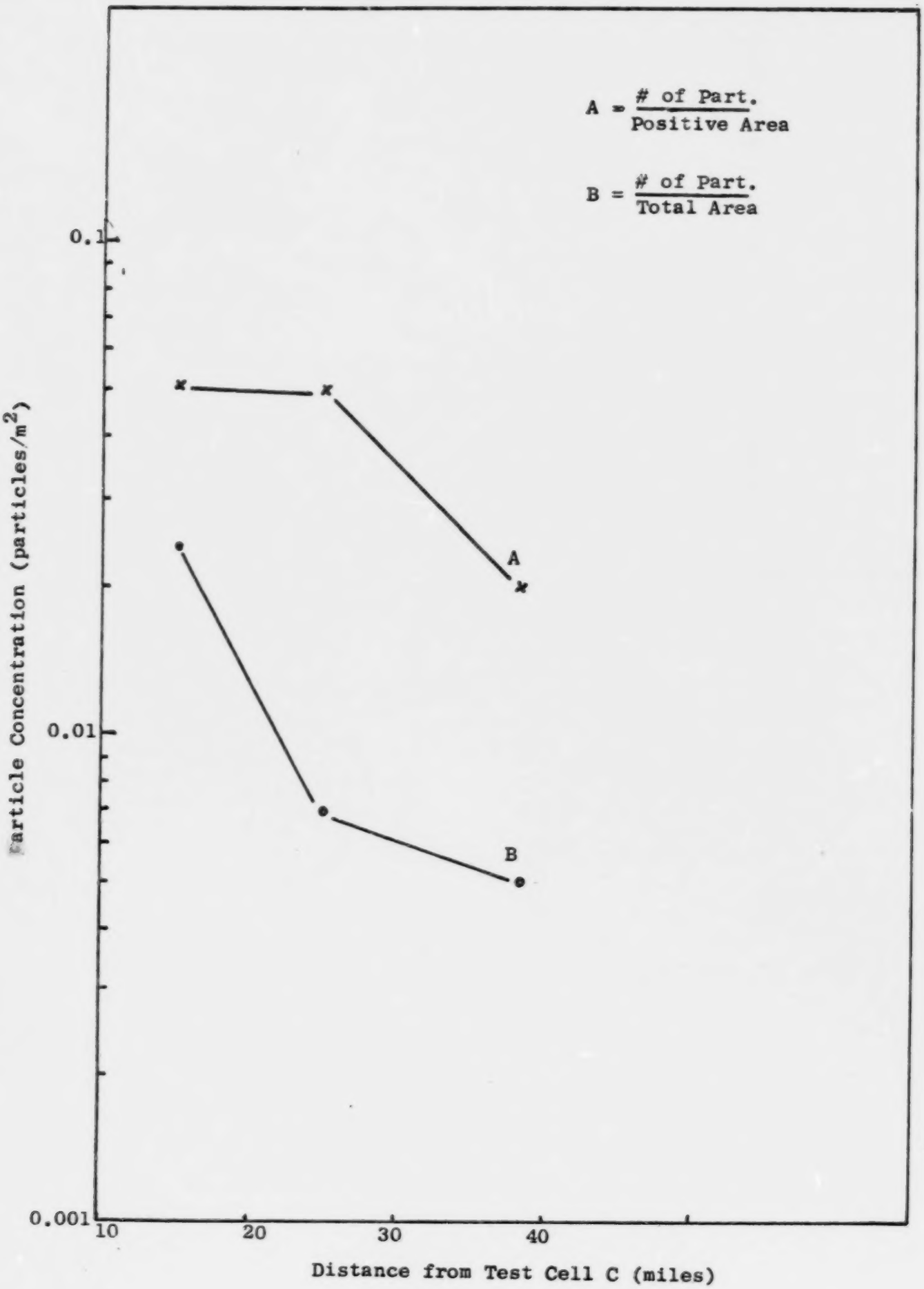

Figure 2. Deposition concentration versus distance - EP-IV.

of particles found along an arc to the total positive location areas versus distance from Test Cell C. Curve B is the ratio of the total number of particles found along an arc to the total area surveyed between edges of the deposition pattern.* As expected, both curves show a decrease in concentration with distance.

On Run + 1 and 2 days, nineteen particles which measured greater than 100 mR/hr (open probe on an E-500B) were picked up for a special biological study. These particles were collected within a one mile radius of CP-1, but were not considered in concentration calculations.

C. Field Results - EP-V

Survey results for EP-V are presented in Table A-2. Figure 3 shows sampling locations and particle concentrations. The major activity was found between 13° and 21° with no defined hotline. The lack of definition of a hotline may be due to weather or the starting, stopping, and restarting of the reactor.

A three dimensional representation of particle deposition concentration is shown in Figure 4. The concentrations are in particles per square meter.

The change in average deposition concentration with distance is shown in Figure 5, in the same manner as Figure 2. The curves show a decrease in concentration with distance.

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*For example, on the 40 mile arc, after EP-IV, a total of three particles were found between 49 and 65 degrees. One particle was found at each of three locations (positive area = 150 m^3). For Curve A this would represent a value of 3/150 or 0.02. A total of twelve areas (600 m^2) were surveyed between 49 and 65 degrees. For Curve B this would represent a value of 3/600 or 0.005.

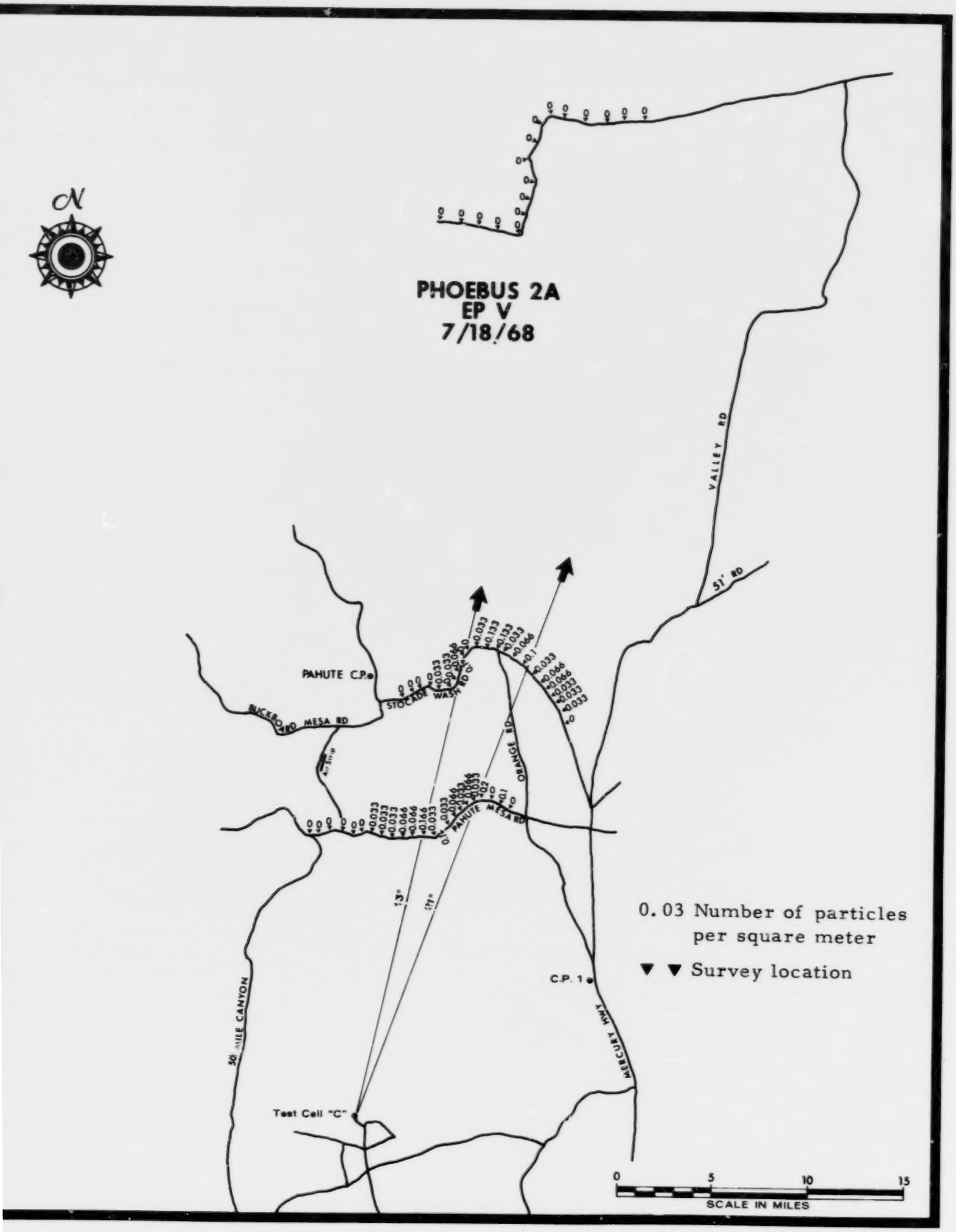

Figure 3. Sampling locations and particle concentrations - EP-V.

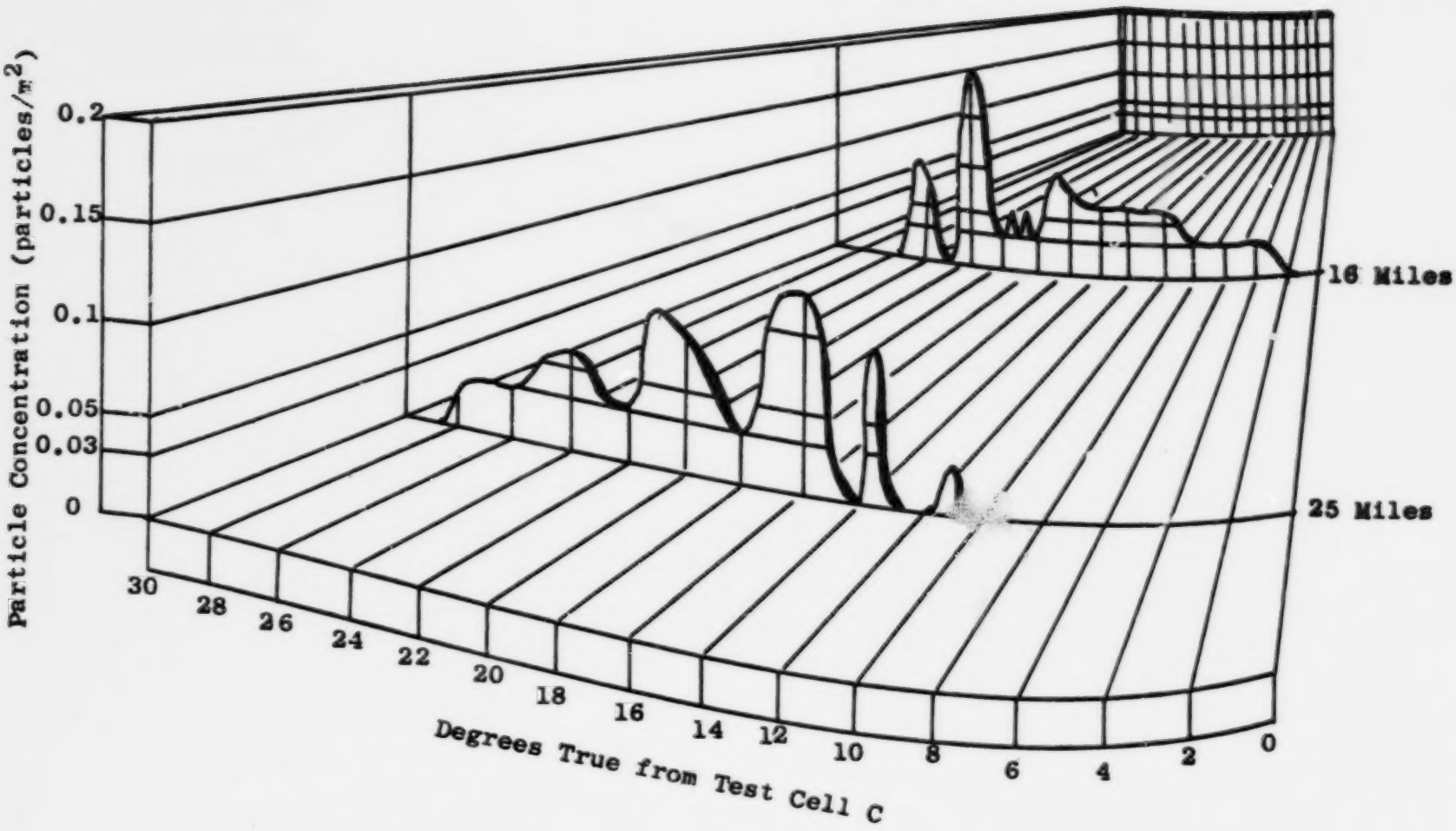

Figure 4. Survey results in three dimensional representation - EP-V.

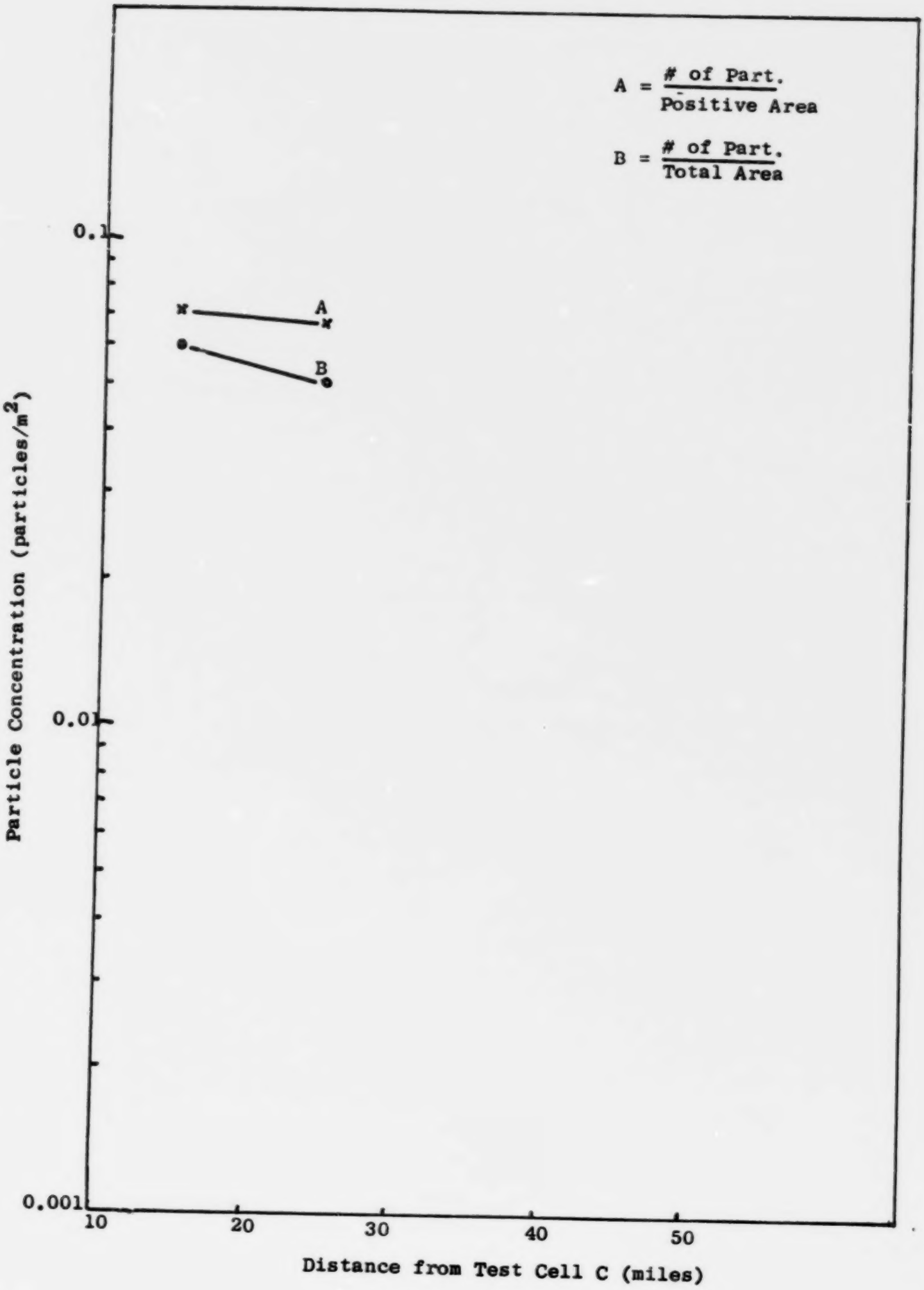

Figure 5. Deposition concentration versus distance - EP-V.

D. Discussion of Field Results

The field results are similar to previous tests (1). Weather at the time of the EP-IV run showed an unstable vertical temperature structure with light and variable winds. Inspection of field data indicated a widespread deposition with no defined hotline which was probably due to the light and variable winds. The peak particle concentration is lower by a factor of two than was anticipated from post-run predictions (4).

On EP-V, the weather conditions were more stable than on EP-IV. The multi-peak deposition patterns, as shown on Figure 4, may be due to wind shear at the time of the run (3). The particle concentration for EP-V is higher by a factor of three than was predicted (4).

Both experiments showed a decrease in particle concentration with distance, Figures 2 and 5. Curves A, on both figures, had approximately the same slope. These curves are similar to those for previous tests (1) for the same distances.

IV. LABORATORY ASSAY

All samples were returned to SWRHL for analysis. After the radioactive material was separated from the matrix, physical measurements were made. On selected samples, radiometric and microprobe analyses were performed. Analytical procedures were the same for both EP-IV and EP-V.

A. Separation and Location

Initial separation was performed by dividing the sample into small portions and checking each portion with a laboratory radiation monitor. The portions containing activity were mounted on 1" x 3" glass slides using collodion.

The use of latex (see Appendix A) during collection kept particle fracturing to a minimum. In a few cases more than one active portion was obtained from a sample, but this was minimal when compared with previous particle separation (1). A radioautographic technique was used to precisely locate the radioactive material. After location, the collodion used to hold the material was starred for future reference.

B. Physical Characteristics

A microscope was used to determine the appearance and size of the material. Most particles were large enough to be sized at 100x magnification. The radioactive material appeared to be porous, black to reddish color, and somewhat spherical. Some of the particles were quite fragile and shattered when touched.

All particles collected from both tests were sized. Sizing was accomplished using a filar micrometer eyepiece in the microscope to measure the maximum dimension and the dimension perpendicular to the maximum (9). Table A-3 presents the size data for EP-IV. Table A-4 presents data from the EP-IV special samples, which were collected in the CP-1 area without regard to area covered; therefore, no specific location is given. Table A-5 presents the size data from EP-V. The equivalent diameter, defined as the square root of the product of the two measurements, is given in parentheses, Tables A-3 and A-5. Some specimens had more than one particle (due to fracturing) and an equivalent diameter was not calculated.

Fall velocity was measured on a few selected particles using an air column and a liquid column. One particle from EP-IV (Sample No. 399) and three of the most active particles from EP-V were dropped in free air in a vertically mounted, one-inch diameter (I.D.) glass tube. Two NaI(Tl) detectors were positioned 10 feet apart on the tube. The signals from the detectors were fed into a multi-channel analyzer operating in the multi-scaler mode. Fall-time

was determined from the interval between detection of the particle at each detector. Each particle was dropped at least twice; two were dropped four times. The average of these times was used in the calculations. Data from the tests are presented in Table 3.

TABLE 3

Fall Velocity
Free Air Column*

SAMPLE NO.	DIAMETER - μ (Equivalent Area)	DISTANCE OF FALL (cm)	TIME OF FALL (sec)	FALL VELOCITY (cm/sec)
399	164	304.8	3.7 3.8	81.9
503	50	304.8	10.7 13.3 14.8 12.0	24
541	153	304.8	3.4 3.4 3.4 3.4	89.7
542B	65.4	304.8	5.7 5.7 5.9	52.8

*Viscosity - 182.7 micropoises

After being dropped in the air column, the particles were isolated so they could be dropped in a liquid column (1). Samples 399 and 503 shattered in the isolation process. The data obtained from Sample 541 and 542B are presented in Table 4.

TABLE 4

Fall Velocity
Liquid Column*

SAMPLE NO.	DIAMETER - μ (Equivalent Area)	DISTANCE OF FALL (cm)	TIME OF FALL (sec)	FALL VELOCITY (cm/sec)
541	153	20.79	29.3	0.71
542B	76.3	20.79	97.0	0.21

*Fluid Viscosity - 2.67 centipoises
Fluid Density - 0.883 grams per cubic centimeter

An attempt was made to determine the density of the particles from Stokes', Rubey's, and Oseen's equations (8). Values of 1.51, 15.7, and 2.49, respectively, were obtained. The wide variation in calculated densities is due to the non-applicability of the equations used. Due to the relatively large size and mass, all particles had Reynolds numbers outside of the range for which the equations were valid. An empirical calibration will be performed with similar material. These results will be reported in a later paper.

C. Radiometric Analysis

All specimens from EP-IV were beta counted and gamma scanned. Alpha counting was not attempted because the method of mounting the material with 30% collodion covered the sample. All specimens from EP-V were beta counted and 22 were gamma scanned.

Beta activity is reported in dpm, fissions*, and picocuries for individual specimens. Table A-6 presents data for EP-IV as of July 9, 1968, while Table A-7 presents data for EP-V as of July 23, 1968. Locations (azimuth and distance from Test Cell C) are also given in each table. Eleven specimens from EP-IV and ten

*The activity in fissions is a normalization of activity.

from EP-V were beta counted over an extended period of time to follow decay and to determine the average maximum beta energy. Decay curves of the samples plotted on log-log paper had essentially the same shape and slope indicating sample similarity. Comparison of the decay curves with published data (5) shows reasonable agreement with gross mixed fission product decay, Figure 6.

Beta absorption tests, using aluminum absorbers, were run concurrently with beta decays. The average maximum beta energy for each specimen was determined from the half-thickness value of aluminum absorbers and was used to select the counting efficiency. All absorption curves were about the same shape. The average maximum beta energy for the specimens was about 1.3 MeV and no trends were observed as a function of age. The average maximum beta energy is close to the 1.2 MeV reported for gross mixed fission products (6).

Gamma scanning was performed on a multi-channel analyzer with a 4" x 4" NaI(Tl) detector. The data were reduced by hand using a series of gamma scans to obtain qualitative and quantitative information.

Table A-8 presents the isotopic data for EP-IV. There were indications of ^{91}Sr, ^{97}Zr, and ^{239}Np, but lack of sufficient counting data made quantitative values questionable. The reported values have been extrapolated to 1409 on run day (6/26/68).

Table A-9 presents the isotopic data for EP-V. These values have been extrapolated to 1608 on run day (7/26/68). The percent of each isotope due to EP-V is given in parentheses at the top of the column. This percentage was calculated from the power integrals from each run and the decay time between the runs.

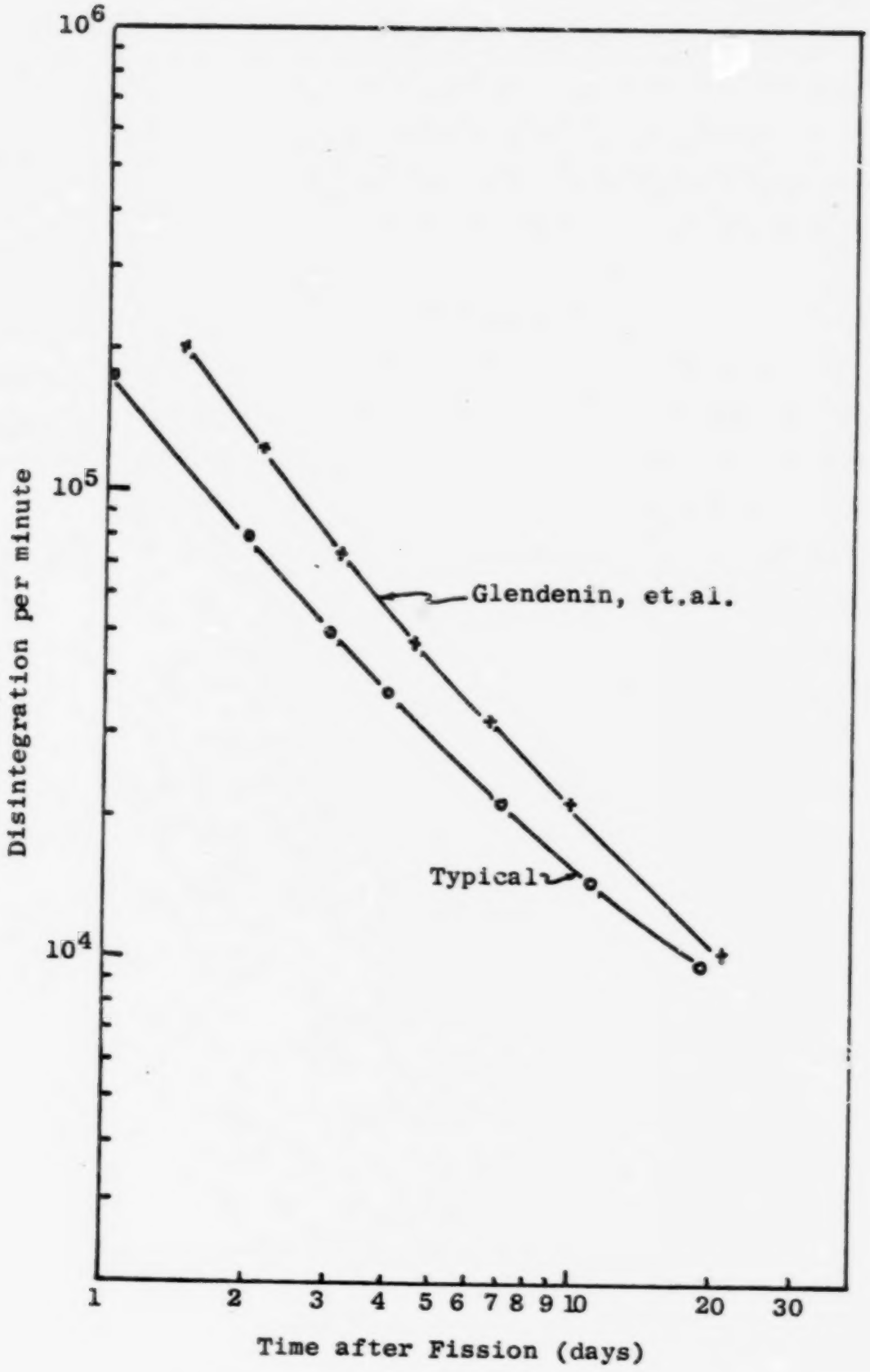

Figure 6. Typical beta decay versus theoretical.

D. Microprobe Analysis

Electron microprobe and X-ray diffraction analyses were performed on seven specimens. Microprobe examination was made to determine the elemental composition of the specimen and X-ray diffraction analysis was made to determine the chemical composition. The microprobe and X-ray diffraction data are reported in Table A-10. The elements and compounds are listed in order of decreasing concentration. Samples D-1 and D-2 were samples from the fall velocity tests, but individual particles could not be recovered from the liquid column for microprobe or diffraction examination.

Sample 417 indicated niobium with the electron microprobe, but X-ray diffraction did not show compounds of niobium. While this may be an artifact of the orientation of the analysis, this suggests that niobium was not a major component of the particle.

E. Discussion of Laboratory Results

The size data from EP-IV were not suitable for size-frequency distribution calculations because of the small amount of non-fractured particles. The size-frequency distribution for EP-V was calculated using an equivalent area diameter for those particles that were not fractured. On the 15 mile arc, 27 of 41 (66%) were not fractured and were used in the calculations. On the 25 mile arc, 24 of 33 (73%) were used. The difficulty in trying to "glue" fractured particles together limited the use of the remaining specimens.

The calculated (7) results of the size-frequency distribution are presented in Table A-11. The graphical results are presented in Figure 7. The larger geometric mean diameter at the 25 mile arc is caused by the difference in size distributions below 70 μ. This difference may be real, but is probably due to the relative small numbers of particles from each arc.

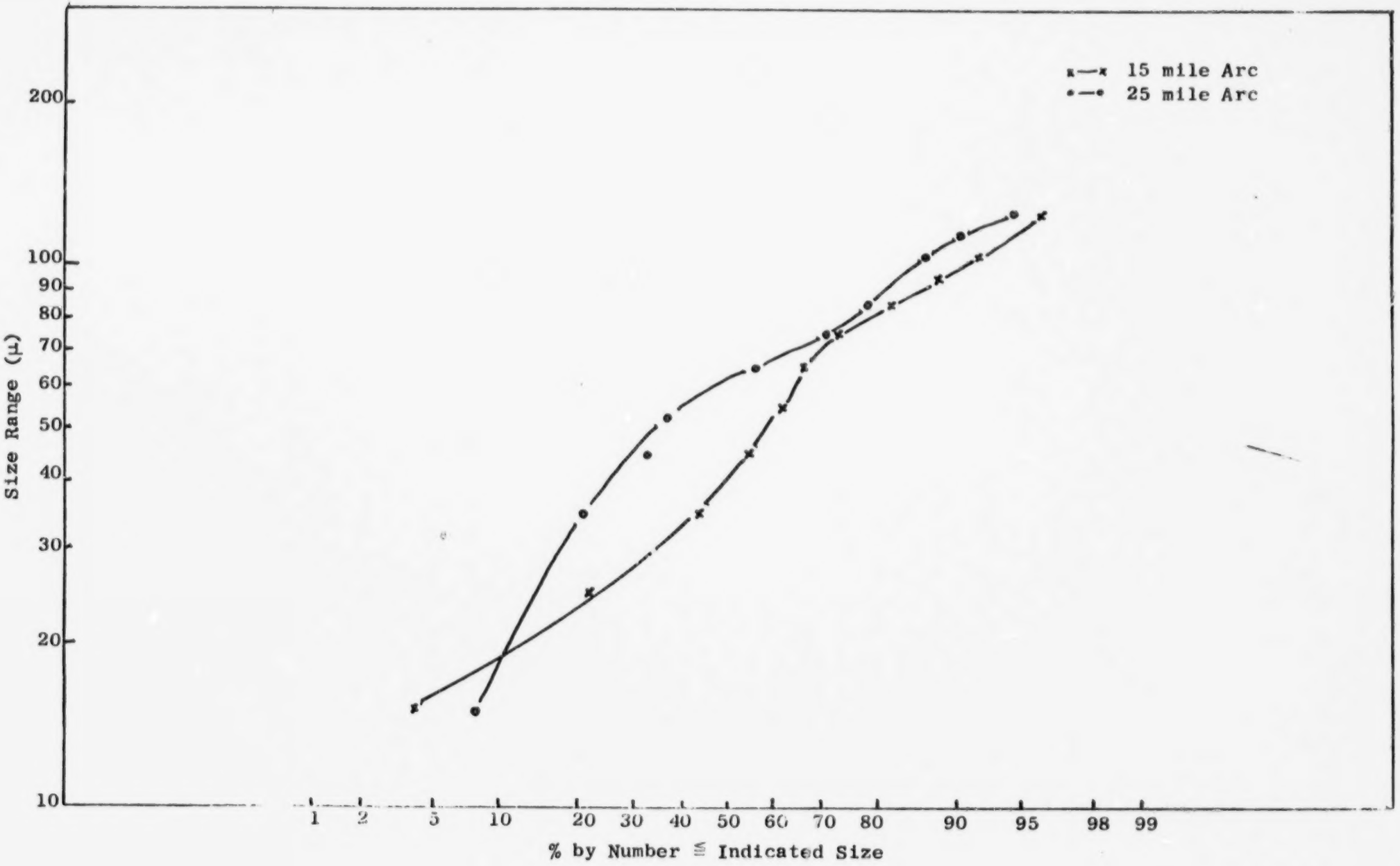

Figure 7. Size frequency distribution - EP-V.

A linear regression of activity and size for EP-IV gave the following equation:

$$\text{Fissions} \times 10^{10} = 0.033 \times \text{size } (\mu) - 0.165$$

The value 0.033 had a range of 0.009 to 0.056 at the 95% C.L., while the constant -0.165 was between -1.28 and 0.96 (95% C.L.). A correlation coefficient of 0.73 was found, which indicates a fairly strong correlation between size and activity, even though a limited amount of data were available. The data are presented graphically in Figure 8.

The correlation of activity and size for EP-V data gave the following equation:

$$\text{Fissions} \times 10^{10} = 0.105 \times \text{size } (\mu) - 3.4$$

The best estimate of the relationship between X and Y, 0.105, had the range of 0.062 to 0.148 (95% C.L.). The best estimate of the constant, -3.4, had the range of -6.45 to -0.35. A correlation coefficient of 0.573 was found for this data. Even though the EP-V correlation coefficient is not as high as the EP-IV coefficient, it does indicate the two variables are not independent of each other. The data used are presented graphically in Figure 9. The circled points in Figure 9 are EP-IV data. It can be seen that they fit within the range of values found for EP-V data.

Theoretical abundances of ^{235}U fission products at one hour after fission relative to ^{99}Mo, were obtained from Bolles and Ballou (5). Isotopic values identified for each sample were also related to the amount of ^{99}Mo found. These ratios are presented in Table A-12. The ratio calculated for each sample was divided by the corresponding ratio calculated from Bolles and Ballou to determine an "enrichment factor" for the isotope relative to the amount expected. These enrichment factors are presented in Table A-13.

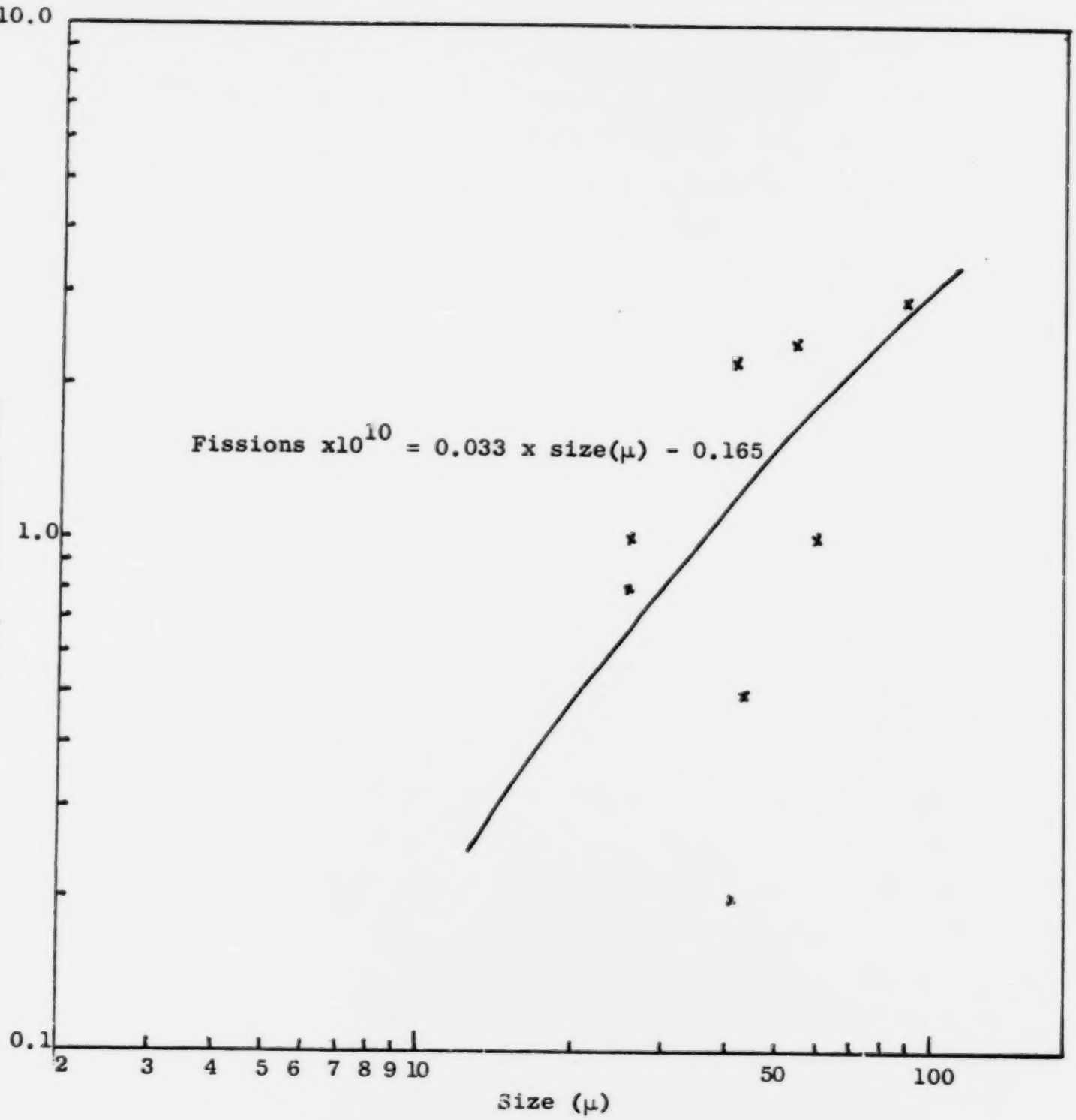

Figure 8. Activity versus size EP-V.

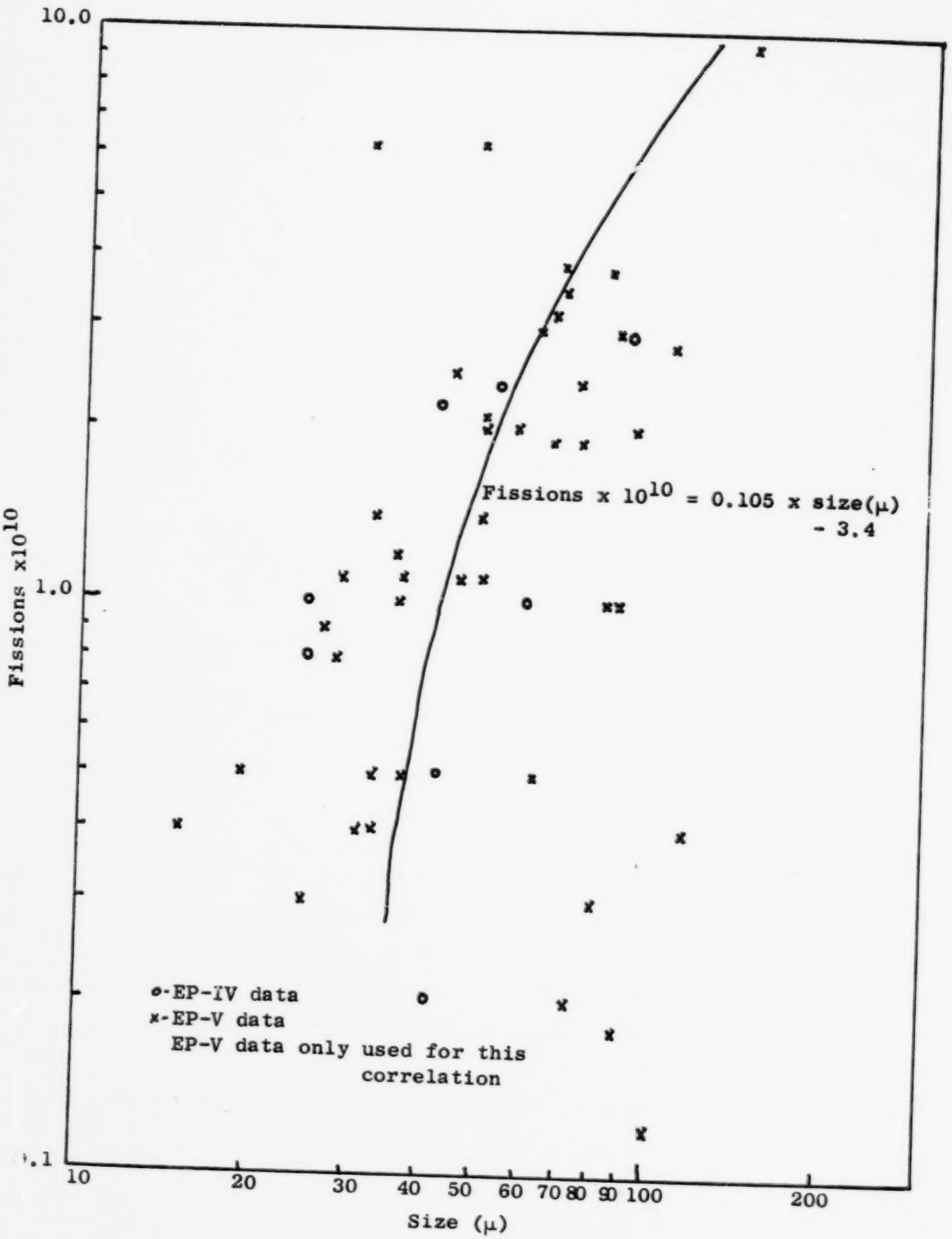

Figure 9. Size versus activity - EP-V.

Table A-13 shows that ^{91}Sr, ^{133}I, and ^{140}Ba are about as expected. The other isotopes seem to be enriched considerably. It may also mean that ^{99}Mo, ^{91}Sr, ^{133}I, and ^{140}Ba are depleted relative to the other isotopes.

V. INTERPRETATION OF FIELD AND LABORATORY RESULTS

Comparison of activity per unit area and distance shows a decrease of activity per unit area with distance for EP-IV, Figure 10. The activity per unit area is calculated by dividing the activity for an arc by the total area*.

Figures 8 and 10 indicate a possible correlation of size and distance for EP-IV. However, the limited number of particles found on this EP does not warrant the expansion of the data.

Table A-11 and Figure 11 both show a slight increase of particle size with distance between 15 and 25 miles on EP-V. Figure 10 demonstrates this, also, with an increase in activity from 15 to 25 miles. The correlation between Table A-11 and Figure 10 is consistent with the positive correlation found between particle size and activity.

VI. SUMMARY

Both EP-IV and EP-V of the Phoebus 2A reactor ejected fragile particles which registered several mR/hr to several hundred mR/hr at a few inches with the open probe of an E-500B. Particles were located and sampled out to about 40 miles. Field results were similar to previous reactor tests. The material collected had properties similar to that collected following previous tests. Electron microprobe and X-ray diffraction analysis showed that the particles were composed of reactor core material.

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*Total area is the total plot area as defined on Page 5.

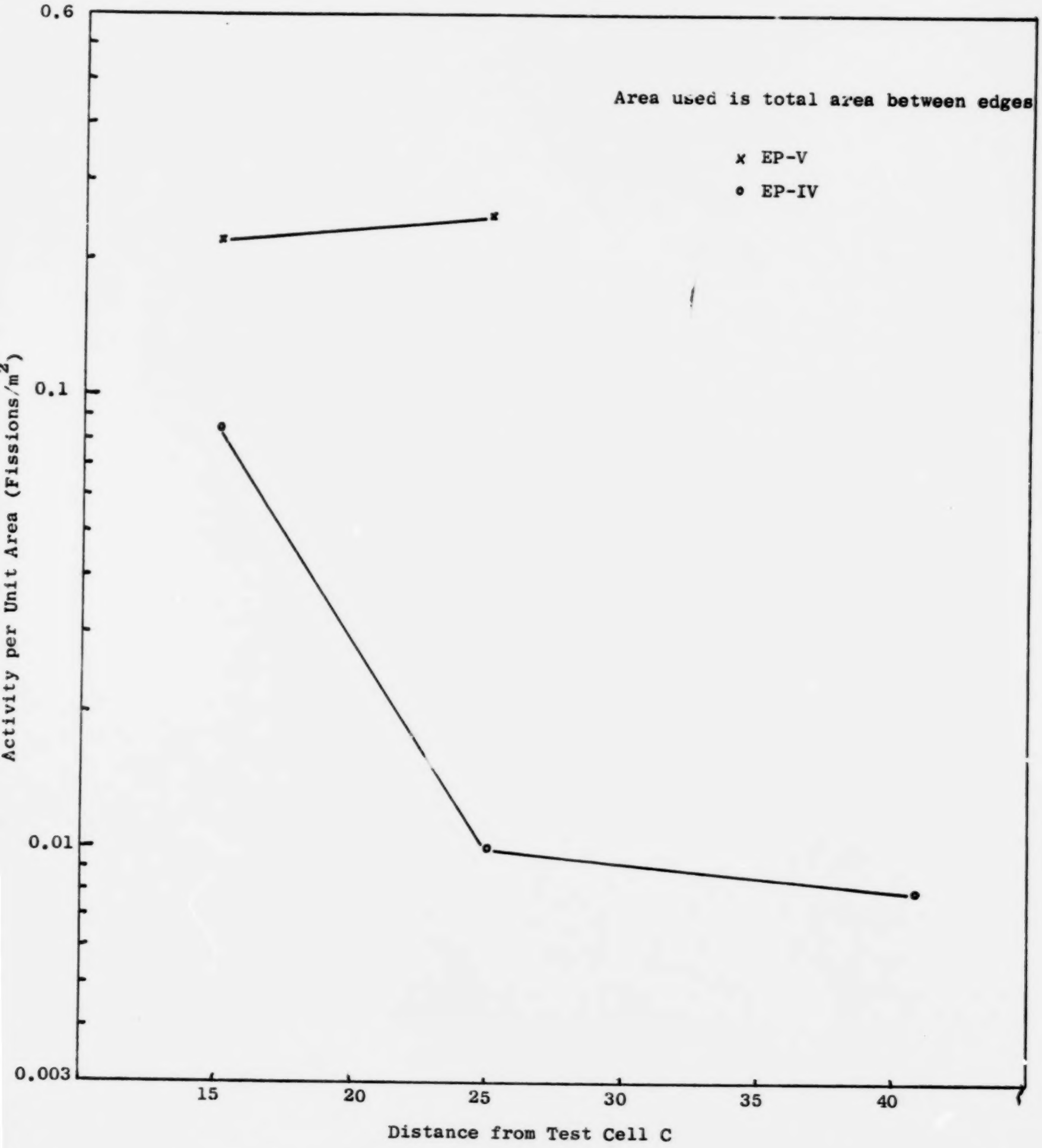

Figure 10. Activity per unit area versus distance.

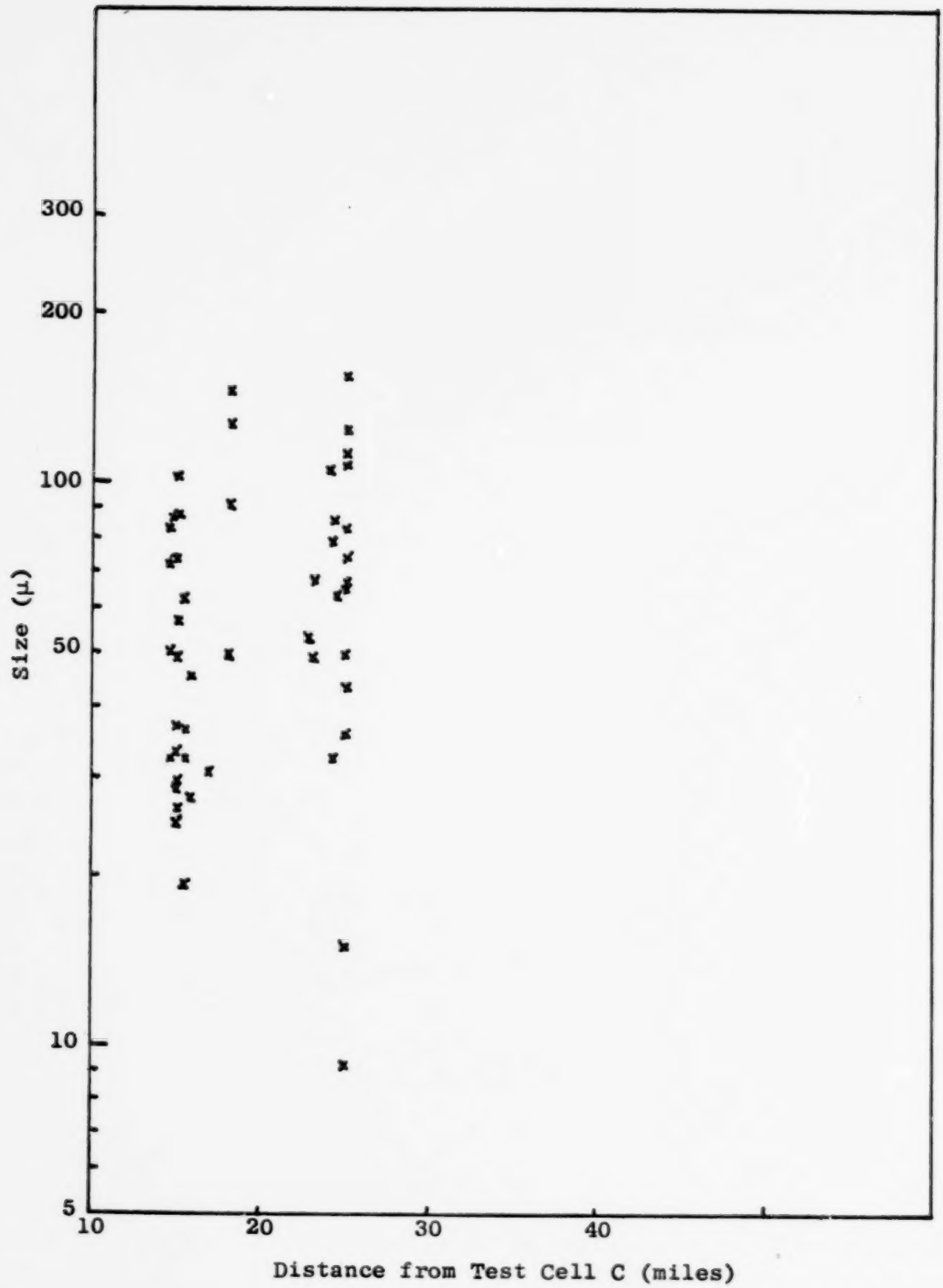

Figure 11. Scatter diagram of size versus distance - EP-V.

A correlation of size versus activity was obtained for both EP's with the correlation coefficient for EP-IV being 0.73 and 0.57 for EP-V. The particle concentration decreased with distance but specific inverse relationships could not be developed.

DEFINITION OF TERMS

Particle - Reactor material, may be beads, shells, flakes, etc., identified as a single hot spot in the survey of a one-square-meter plot.

Particle Concentration - Number of particles per unit area, as determined from the survey.

Sample - The volume of material (sand and reactor material) collected with one identifiable hot spot obtained in the field, i.e., Sample 404.

Specimen - The volume of material containing activity from a sample, i.e., 500A, 500B, etc., mounted on a 1" x 3" glass slide - more than one radioactive specimen may result from a single sample (particle) due to fracturing, separation, etc.

Location - Place identified by azimuth and distance at which a specific number of one-square-meter areas were surveyed.

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APPENDIX A

Sampling Instructions

1. Drive to the designated area.

2. At a distance of at least 50 feet from the road, place a one-meter square template on the ground as many times as necessary to obtain the specified plot area. (Example - an arc at 16 miles, 30 placements of the template would be required).

3. With an E-500B survey instrument, search the area inside each template for hot spots. Trace a path back and forth across the area, sweeping a one foot wide path, with the probe held horizontally six inches above the ground. The beta shield will be opened and facing downward.

4. After a hot spot is found, spray the area with a thin film of latex. Continue on to complete the area.

5. After the latex has dried, peel up and place in a container. Label each container and record information on log sheet.

6. Move to the next sampling plot and repeat.

APPENDIX A

TABLE A-1

SAMPLE LOCATION
EP-IV

DATE COLLECTED	LOCATION	AZIMUTH FROM TEST CELL C (°True)	DISTANCE FROM TEST CELL C (mi)	NO. OF PARTICLES PER AREA SURVEYED (m^2)	PARTICLE CONCENTRATION (part./m^2)
6/26/68	Junction - Orange Road and Pahute Mesa Road	30	18	0/30	0.0
6/26/68	0.5 mi S Junction Orange Road and Pahute Mesa Road	31	17.5	0/30	0.0
6/26/68	1 mi S Junction Orange Road and Pahute Mesa Road	32	17	0/30	0.0
6/26/68	1.5 mi S Junction Orange Road and Pahute Mesa Road	34	17	0/30	0.0
6/26/68	2 mi S Junction Orange Road and Pahute Mesa Road	36	17	0/30	0.0
62/6/68	2.5 mi S Junction Orange Road and Pahute Mesa Road	38	17	0/30	0.0
6/26/68	3 mi S Junction Orange Road and Pahute Mesa Road	40	16.5	1/30	0.033
6/26/68	3.5 mi S Junction Orange Road and Pahute Mesa Road	42	16	2/30*	0.066
6/26/68	4 mi S Junction Orange Road and Pahute Mesa Road	43	16	2/30	0.066
6/26/68	4.5 mi S Junction Orange Road and Pahute Mesa Road	44.5	15	0/30	0.0
6/26/68	5 mi S Junction Orange Road and Pahute Mesa Road	46	15.5	0/30	0.0

*Not recovered from field.

TABLE A-1 (cont)

DATE COLLECTED	LOCATION	AZIMUTH FROM TEST CELL C (° True)	DISTANCE FROM TEST CELL C (mi)	NO. OF PARTICLES PER AREA SURVEYED (m^2)	PARTICLE CONCENTRATION (part./m2)
6/26/68	5.5 mi S Junction Orange Road and Pahute Mesa Road	48	15.5	0/30	0.0
6/26/68	6 mi S Junction Orange Road and Pahute Mesa Road	50	15	1/30	0.033
6/26/68	6.5 mi S Junction Orange Road and Pahute Mesa Road	52.5	15	0/30	0.0
6/26/68	7 mi S Junction Orange Road and Pahute Mesa Road	54.5	15	1/30	0.033
6/26/68	7.5 mi S Junction Orange Road and Pahute Mesa Road	57	14.5	0/30	0.0
6/26/68	Junction - Orange Road and Mercury Highway	59	14.5	2/30	0.066
6/26/68	0.5 mi S Junction Orange Road and Mercury Highway	61	14	0/30	0.0
6/26/68	1 mi S Junction Orange Road and Mercury Highway	63	14	0/30	0.0
6/26/68	1.5 mi S Junction Orange Road and Mercury Highway	66	14	2/30	0.066
6/26/68	2 mi S Junction Orange Road and Mercury Highway	68	14	2/30	0.066
6/26/68	2.5 mi S Junction Orange Road and Mercury Highway	70	14	0/30	0.0
6/26/68	3 mi S Junction Orange Road and Mercury Highway	72	14	0/30	0.0

TABLE A-1 (cont)

DATE COLLECTED	LOCATION	AZIMUTH FROM TEST CELL C (°True)	DISTANCE FROM TEST CELL C (mi)	NO. OF PARTICLES PER AREA SURVEYED (m^2)	PARTICLE CONCENTRATION (part./m^2)
6/26/68	3.5 mi S Junction Orange Road and Mercury Highway	74	14.5	2/30	0.066
6/26/68	4 mi S Junction Orange Road and Mercury Highway	76	14.5	1/30	0.033
6/26/68	4.5 mi S Junction Orange Road and Mercury Highway	78	14.5	0/30	0.0
6/26/68	5 mi S Junction Orange Road and Mercury Highway	80	14.5	0/30	0.0
6/26/68	5.5 mi S Junction Orange Road and Mercury Highway	82	14.5	0/30	0.0
6/26/68	6 mi S Junction Orange Road and Mercury Highway	85	14.5	0/30	0.0
6/26/68	6.5 mi S Junction Orange Road and Mercury Highway	87	14.5	1/30	0.033
6/26/68	7 mi S Junction Orange Road and Mercury Highway	89	14.5	0/30	0.0
6/26/68	7.5 mi S Junction Orange Road and Mercury Highway	91	14.5	0/30	0.0
6/26/68	8 mi S Junction Orange Road and Mercury Highway	93	14.5	0/30	0.0
6/26/68	8.5 mi S Junction Orange Road and Mercury Highway	95	14.5	0/30	0.0
6/26/68	9 mi S Junction Orange Road and Mercury Highway	97	14.5	0/30	0.0

TABLE A-1 (cont)

DATE COLLECTED	LOCATION	AZIMUTH FROM TEST CELL C (°True)	DISTANCE FROM TEST CELL C (mi)	NO. OF PARTICLES PER AREA SURVEYED (m^2)	PARTICLE CONCENTRATION (part./m^2)
6/26/68	9.5 mi S Junction Orange Road and Mercury Highway	99.5	14.5	0/30	0.0
6/26/68	10 mi S Junction Orange Road and Mercury Highway	102	14.5	0/30	0.0
6/26/68	10.5 mi S Junction Orange Road and Mercury Highway	103.5	14.5	0/30	0.0
6/26/68	11 mi S Junction Orange Road and Mercury Highway	105	15	0/30	0.0
6/26/68	11.5 mi S Junction Orange Road and Mercury Highway	106	15.5	0/30	0.0
6/26/68	12 mi S Junction Orange Road and Mercury Highway	108	16	0/30	0.0
6/26/68	12.5 mi S Junction Orange Road and Mercury Highway	109.5	16	0/30	0.0
6/26/68	13 mi S Junction Orange Road and Mercury Highway	110.5	16.5	0/30	0.0
6/26/68	13.5 mi S Junction Orange Road and Mercury Highway	111	17	0/30	0.0
6/26/68	14 mi S Junction Orange Road and Mercury Highway	112	17.5	0/30	0.0
6/26/68	Junction - Mercury Highway and Short Pole Road	113	18	0/30	0.0
6/27/68	Camera Station Butte	49	21.5	2/30	0.066
6/27/68	0.5 mi E Camera Station Butte	47.4	21	0/30	0.0

TABLE A-1 (cont)

DATE COLLECTED	LOCATION	AZIMUTH FROM TEST CELL C (° True)	DISTANCE FROM TEST CELL C (mi)	NO. OF PARTICLES PER AREA SURVEYED (m^2)	PARTICLE CONCENTRATION (part./m^2)
6/27/68	1 mi E Camera Station Butte	46.5	21	0/30	0.0
6/27/68	1 mi E 0.5 mi N Camera Station Butte	45.5	21	0/30	0.0
6/27/68	1 mi E 1 mi N Camera Station Butte	43	22	0/30	0.0
6/27/68	1.5 mi N Camera Station Butte	42	22.5	0/30	0.0
6/27/68	2 mi N Camera Station Butte	41	23	0/30	0.0
6/27/68	2.5 mi N Camera Station Butte	40	23.5	0/30	0.0
6/27/68	3 mi N Camera Station Butte	38.5	24	0/30	0.0
6/27/68	3.5 mi N Camera Station Butte	38	24.5	0/30	0.0
6/27/68	4 mi N Junction Papoose Lake Road	39	25	0/30	0.0
6/27/68	0.5 mi E Junction Papoose Lake Road	40	25.5	0/30	0.0
6/27/68	1 mi E Junction Papoose Lake Road	41	24.5	0/30	0.0
6/27/68	1.5 mi E Junction Papoose Lake Road	42.5	25.5	0/30	0.0
6/27/68	2 mi E Junction Papoose Lake Road	44	26	0/30	0.0
6/27/68	2.5 mi E Junction Papoose Lake Road	45	26.5	0/30	0.0
6/27/68	Junction - East Fort Scarp Canyon Road	46.5	26	0/30	0.0
6/27/68	0.5 mi S Junction East Fork Scarp Canyon Road	47.5	25.5	0/30	0.0

TABLE A-1 (cont)

DATE COLLECTED	LOCATION	AZIMUTH FROM TEST CELL C (°True)	DISTANCE FROM TEST CELL C (mi)	NO. OF PARTICLES PER AREA SURVEYED (m^2)	PARTICLE CONCENTRATION (part./m^2)
6/27/68	1 mi S Junction East Fork Scarp Canyon Road	48.5	25	0/30	0.0
6/27/68	1.5 mi S Junction East Fork Scarp Canyon Road	49.5	25	0/30	0.0
6/27/68	2 mi S Junction East Fork Scarp Canyon Road	50.5	25	0/30	0.0
6/27/68	2.5 mi S Junction East Fork Scarp Canyon Road	52	24.5	0/30	0.0
6/27/68	3 mi S Junction East Fork Scarp Canyon Road	53	24	0/30	0.0
6/27/68	3.5 mi S Junction East Fork Scarp Canyon Road	54	24	0/30	0.0
6/27/68	4 mi S Junction East Fork Scarp Canyon Road	55	23.5	0/30	0.0
6/27/68	4.5 mi S Junction East Fork Scarp Canyon Road	56	23.5	0/30	0.0
6/27/68	5 mi S Junction East Fork Scarp Canyon Road	56.5	23	0/30	0.0
6/27/68	5.5 mi S Junction East Fork Scarp Canyon Road	57.5	23	0/30	0.0
6/27/68	6 mi S Junction East Fork Scarp Canyon Road	58.5	23	0/30	0.0
6/27/68	6.5 mi S Junction East Fork Scarp Canyon Road	59.5	22.5	0/30	0.0

TABLE A-1 (cont)

DATE COLLECTED	LOCATION	AZIMUTH FROM TEST CELL C (°True)	DISTANCE FROM TEST CELL C (mi)	NO. OF PARTICLES PER AREA SURVEYED (m^2)	PARTICLE CONCENTRATION (part./m^2)
6/27/68	7 mi S Junction East Fork Scarp Canyon Road	61	22.5	0/30	0.0
6/27/68	7.5 mi S Junction East Fork Scarp Canyon Road	62	22	0/30	0.0
6/27/68	8 mi S Junction East Fork Scarp Canyon Road	63	22	1/30	0.033
6/27/68	8.5 mi S Junction East Fork Scarp Canyon Road	64.5	21.5	0/30	0.0
6/27/68	9 mi S Junction East Fork Scarp Canyon Road	66	21.5	0/30	0.0
6/27/68	9.5 mi S Junction East Fork Scarp Canyon Road	67	21.5	0/30	0.0
6/27/68	10 mi S Junction East Fork Scarp Canyon Road	68.5	21.5	0/30	0.0
6/27/68	10.5 mi S Junction East Fork Scarp Canyon Road	70	21.5	0/30	0.0
6/27/68	11 mi S Junction East Fork Scarp Canyon Road	71.5	21.5	0/30	0.0
6/27/68	11.5 mi S Junction East Fork Scarp Canyon Road	73	21	0/30	0.0
6/27/68	12 mi S Junction East Fork Scarp Canyon Road	74.5	21	0/30	0.0
6/27/68	12.5 mi S Junction East Fork Scarp Canyon Road	76	21.5	0/30	0.0

TABLE A-1 (cont)

DATE COLLECTED	LOCATION	AZIMUTH FROM TEST CELL C (°True)	DISTANCE FROM TEST CELL C (mi)	NO. OF PARTICLES PER AREA SURVEYED (m^2)	PARTICLE CONCENTRATION (part./m^2)
6/27/68	13 mi S Junction East Fork Scarp Canyon Road (Junction - Scarp Canyon and Nye Canyon)	78.5	21	0/30	0.0
6/27/68	SE edge Groom Lake	45	40	0/50	0.0
6/27/68	1 mi S SE edge Groom Lake	46	39.5	0/50	0.0
6/27/68	2 mi S SE edge Groom Lake	48	39.5	0/50	0.0
6/27/68	3 mi S SE edge Groom Lake	49	39	1/50	0.0
6/27/68	4 mi S SE edge Groom Lake	50.5	39	0/50	0.0
6/27/68	5 mi S SE edge Groom Lake	52	38.5	1/50	0.0
6/27/68	6 mi S SE edge Groom Lake	53.5	38.5	0/50	0.0
6/27/68	7 mi S SE edge Groom Lake	55	38.5	0/50	0.0
6/27/68	8 mi S SE edge Groom Lake	56.5	38	0/50	0.0
6/27/68	9 mi S SE edge Groom Lake	58	37.5	0/50	0.0
6/27/68	10 mi S SE edge Groom Lake	59.5	37.5	0/50	0.0
6/27/68	11 mi S SE edge Groom Lake	61	37	0/50	0.0
6/27/68	12 mi S SE edge Groom Lake	63.5	37	0/50	0.0
6/27/68	13 mi S SE edge Groom Lake	64	37.5	0/50	0.0
6/27/68	14 mi S SE edge Groom Lake	65	38	1/50	0.02

TABLE A-1 (cont)

DATE COLLECTED	LOCATION	AZIMUTH FROM TEST CELL C (°True)	DISTANCE FROM TEST CELL C (mi)	NO. OF PARTICLES PER AREA SURVEYED (m^2)	PARTICLE CONCENTRATION (part./m^2)
6/27/68	15 mi S SE edge Groom Lake	67	38	0/50	0.0
6/27/68	16 mi S SE edge Groom Lake	68.5	38	0/50	0.0
6/27/68	17 mi S SE edge Groom Lake	70	38	0/50	0.0
6/27/68	18 mi S SE edge Groom Lake	71.5	38	0/50	0.0
6/27/68	19 mi S SE edge Groom Lake	73	37.5	0/50	0.0
6/27/68	20 mi S SE edge Groom Lake	74.5	37	0/50	0.0
6/27/68	21 mi S SE edge Groom Lake	76	36.5	0/50	0.0
6/27/68	6.5 mi S Alamo (Highway 93)	63	110.5	0/100	0.0
6/27/68	7.5 mi S Alamo (Highway 93)	64	110	0/100	0.0
6/27/68	8.5 mi S Alamo (Highway 93)	65	110	0/100	0.0
6/27/68	9.5 mi S Alamo (Highway 93)	66	110	0/100	0.0
6/27/68	10.5 mi S Alamo (Highway 93)	67	110	0/100	0.0
6/27/68	11.5 mi S Alamo (Highway 93)	67.5	110.5	0/100	0.0
6/27/68	12.5 mi S Alamo (Highway 93)	68	110.5	0/100	0.0
6/27/68	13.5 mi S Alamo (Highway 93)	69	111	0/100	0.0
6/27/68	14.5 mi S Alamo (Highway 93)	69.5	111	0/100	0.0
6/27/68	15.5 mi S Alamo (Highway 93)	70	112	0/100	0.0

TABLE A-1 (cont)

DATE COLLECTED	LOCATION	AZIMUTH FROM TEST CELL C ($^{\circ}$True)	DISTANCE FROM TEST CELL C (mi)	NO. OF PARTICLES PER AREA SURVEYED (m^2)	PARTICLE CONCENTRATION (part./m^2)
6/27/68	16.5 mi S Alamo (Highway 93)	70.5	112.5	0/100	0.0
6/27/68	17.5 mi S Alamo (Highway 93)	71	113	0/100	0.0
6/27/68	18.5 mi S Alamo (Highway 93)	72	112.5	0/100	0.0
6/27/68	19.5 mi S Alamo (Highway 93)	72.5	112	0/100	0.0
6/27/68	20.5 mi S Alamo (Highay 93)	73.5	112.5	0/100	0.0
6/27/68	21.5 mi S Alamo (Highway 93)	74.5	112.5	0/100	0.0
6/27/68	22.5 mi S Alamo (Highway 93)	75	112.5	0/100	0.0
6/27/68	23.5 mi S Alamo (Highway 93)	75.5	112.5	0/100	0.0
6/27/68	24.5 mi S Alamo (Highway 93)	76.5	112.5	0/100	0.0
6/27/68	13 mi E Lathrop Wells	164	18	0/30	0.0
6/27/68	13.5 mi E Lathrop Wells	163	18.5	0/30	0.0
6/27/68	14 mi E Lathrop Wells	162	18.5	0/30	0.0
6/27/68	14.5 mi E Lathrop Wells	160	19	0/30	0.0
6/27/68	15 mi E Lathrop Wells	159	19.5	0/30	0.0
6/27/68	15.5 mi E Lathrop Wells	158	19.5	0/30	0.0
6/27/68	16 mi E Lathrop Wells	156	20	0/30	0.0
6/27/68	16.5 mi E Lathrop Wells	155	20	0/30	0.0

TABLE A-1 (cont)

DATE COLLECTED	LOCATION	AZIMUTH FROM TEST CELL C (° True)	DISTANCE FROM TEST CELL C (mi)	NO. OF PARTICLES PER AREA SURVEYED (m^2)	PARTICLE CONCENTRATION (part./m^2)
6/27/68	17 mi E Lathrop Wells	153	20.5	0/30	0.0
6/27/68	17.5 mi E Lathrop Wells	151	20.5	0/30	0.0
6/27/68	18 mi E Lathrop Wells	150	21	0/30	0.0
6/27/68	18.5 mi E Lathrop Wells	148	21	0/30	0.0
6/27/68	19 mi E Lathrop Wells	147	20.5	0/30	0.0

APPENDIX A

TABLE A-2

SAMPLE LOCATION
EP-V

DATE COLLECTED	LOCATION	AZIMUTH FROM TEST CELL C ($^{\circ}$True)	DISTANCE FROM TEST CELL C (mi)	NO. OF PARTICLES PER AREA SURVEYED (m^2)	PARTICLE CONCENTRATION (part./m^2)
7/18/68	Junction - 40 mi Canyon Road and Buckboard Mesa Rd	351	15	0/30	0.0
7/18/68	0.5 mi E Junction 40 mi Canyon Road and Buckboard Mesa Road	352.5	15	0/30	0.0
7/18/68	1 mi E Junction 40 mi Canyon Road and Buckboard Mesa Road	355	15	0/30	0.0
7/18/68	1.5 mi E Junction 40 mi Canyon Road and Buckboard Mesa Road	358	15	0/30	0.0
7/18/68	2 mi E Junction 40 mi Canyon Road and Buckboard Mesa Road	359	14.5	0/30	0.0
7/18/68	2.5 mi E Junction 40 mi Canyon Road and Buckboard Mesa Road	001	14.5	0/30	0.0
7/18/68	3 mi E Junction 40 mi Canyon Road and Buckboard Mesa Road	003.5	14.5	1/30	0.033
7/18/68	3.5 mi E Junction 40 mi Canyon Road and Buckboard Mesa Road	005.5	14.5	1/30	0.033
7/18/68	4 mi E Junction 40 mi Canyon Road and Buckboard Mesa Road	007.5	14.5	1/30	0.033

TABLE A-2 (cont)

DATE COLLECTED	LOCATION	AZIMUTH FROM TEST CELL C (°True)	DISTANCE FROM TEST CELL C (mi)	NO. OF PARTICLES PER AREA SURVEYED (m^2)	PARTICLE CONCENTRATION (part./m^2)
7/18/68	4.5 mi E Junction 40 mi Canyon Road and Buckboard Mesa Road	10	14.5	2/30*	0.066
7/18/68	5 mi E Junction 40 mi Canyon Road and Buckboard Mesa Road	11.5	15	2/30	0.066
7/18/68	5.5 mi E Junction 40 mi Canyon Road and Buckboard Mesa Road	14	15	5/30	0.166
7/18/68	6 mi E Junction 40 mi Canyon Road and Buckboard Mesa Road	15.5	15	1/30	0.033
7/18/68	6.5 mi E Junction 40 mi Canyon Road and Buckboard Mesa Road	17	15.5	3/30	0.1
7/18/68	7 mi E Junction 40 mi Canyon Road and Buckboard Mesa Road	18	16	1/30	0.033
7/19/68	7.5 mi E Junction 40 mi Canyon Road and Buckboard Mesa Road	18.5	16	2/30	0.066
7/19/68	Junction - Buckboard Mesa Road and Pahute Mesa Road	19	16.5	1/30	0.033
7/19/68	0.5 mi E Junction Buckboard Mesa Road and Pahute Mesa Road	19.5	17	2/30	0.066
7/19/68	1 mi E Junction Buckboard Mesa Road and Pahute Mesa Road	20	17.5	1/30	0.033

*1 lost in field recovery

TABLE A-2 (cont)

DATE COLLECTED	LOCATION	AZIMUTH FROM TEST CELL C (° True)	DISTANCE FROM TEST CELL C (mi)	NO. OF PARTICLES PER AREA SURVEYED (m^2)	PARTICLE CONCENTRATION (part./m^2)
7/19/68	1.5 mi E Junction Buckboard Mesa Road and Pahute Mesa Road	22	18	6/30	0.2
7/19/68	2 mi E Junction Buckboard Mesa Road and Pahute Mesa Road	23.5	18	0/30	0.0
7/19/68	2.5 mi E Junction Buckboard Mesa Road and Pahute Mesa Road	25	18	3/30	0.1
7/19/68	3 mi E Junction Buckboard Mesa Road and Pahute Mesa Road	27	18	0/30	0.0
7/19/68	1.5 mi E Junction Pahute Mesa Road and Stockade Wash Road	006.5	22	0/30	0.0
7/19/68	2 mi E Junction Pahute Mesa Road and Stockade Wash Road	007.5	22	0/30	0.0
7/19/68	2.5 mi E Junction Pahute Mesa Road and Stockade Wash Road	008.5	22.5	0/30	0.0
7/19/68	3 mi E Junction Pahute Mesa Road and Stockade Wash Road	10	22.5	0/30	0.0
7/19/68	3.5 mi E Junction Pahute Mesa Road and Stockade Wash Road	11	22.5	1/30	0.033
7/19/68	4 mi E Junction Pahute Mesa Road and Stockade Wash Road	12.5	23	0/30	0.0

TABLE A-2 (cont)

DATE COLLECTED	LOCATION	AZIMUTH FROM TEST CELL C (° True)	DISTANCE FROM TEST CELL C (mi)	NO. OF PARTICLES PER AREA SURVEYED (m^2)	PARTICLE CONCENTRATION (part./m^2)
7/19/68	4.5 mi E Junction Pahute Mesa Road and Stockade Wash Road	13.5	23	1/30	0.033
7/19/68	5 mi E Junction Pahute Mesa Road and Stockade Wash Road	13.5	23.5	2/30	0.066
7/19/68	5.5 mi E Junction Pahute Mesa Road and Stockade Wash Road	13.5	24	3/30	0.1
7/19/68	6 mi E Junction Pahute Mesa Road and Stockade Wash Road	13.5	24.5	0/30	0.0
7/19/68	6.5 mi E Junction Pahute Mesa Road and Stockade Wash Road	14	25	0/30	0.0
7/19/68	7 mi E Junction Pahute Mesa Road and Stockade Wash Road	14.5	25	1/30	0.033
7/19/68	7.5 mi E Junction Pahute Mesa Road and Stockade Wash Road	16	25	4/30	0.133
7/19/68	Junction - Stockade Wash Road and Orange Road	17	25	4/30	0.133
7/19/68	0.5 mi E Junction Stockade Wash Road and Orange Road	18	25	1/30	0.033
7/19/68	1 mi E Junction Stockade Wash Road and Orange Road	19	25	2/30	0.066

TABLE A-2 (cont)

DATE COLLECTED	LOCATION	AZIMUTH FROM TEST CELL C (^{o}True)	DISTANCE FROM TEST CELL C (mi)	NO. OF PARTICLES PER AREA SURVEYED (m^2)	PARTICLE CONCENTRATION (part./m^2)
7/19/68	1.5 mi E Junction Stockade Wash Road and Orange Road	21	25	3/30	0.1
7/19/68	2 mi E Junction Stockade Wash Road and Orange Road	22	24.5	1/30	0.033
7/19/68	2.5 mi E Junction Stockade Wash Road and Orange Road	23	24.5	2/30	0.066
7/19/68	3 mi E Junction Stockade Wash Road and Orange Road	24.5	24	2/30	0.066
7/19/68	3.5 mi E Junction Stockade Wash Road and Orange Road	25	24	1/30	0.033
7/19/68	4 mi E Junction Stockade Wash Road and Orange Road	26	24	1/30	0.033
7/19/68	4.5 mi E Junction Stockade Wash Road and Orange Road	27.5	23.5	1/30	0.033
7/19/68	5 mi E Junction Stockade Wash Road and Orange Road	28.5	23	0/30	0.0
7/19/68	Stake 34 - Kawich Valley	005.5	46.5	0/50	0.0
7/19/68	1 mi E Stake 34 - Kawich Valley	007	46.5	0/50	0.0
7/19/68	2 mi E State 34 - Kawich Valley	008	46	0/50	0.0
7/19/68	3 mi E Stake 34 - Kawich Valley	009	46.5	0/50	0.0
7/19/68	Junction - Stakes 35, 36, 37	10	46	0/50	0.0
7/19/68	1 mi N Junction Stakes 35, 36, 37	11	47	0/50	0.0

TABLE A-2 (cont)

DATE COLLECTED	LOCATION	AZIMUTH FROM TEST CELL C (° True)	DISTANCE FROM TEST CELL C (mi)	NO. OF PARTICLES PER AREA SURVEYED (m^2)	PARTICLE CONCENTRATION (part./m^2)
7/19/68	2 mi N Junction Stakes 35, 36, 37	11	48	0/50	0.0
7/19/68	3 mi N Junction Stakes 35, 36, 37	11	49	0/50	0.0
7/19/68	4 mi N Junction Stakes 35, 36, 37	11	50	0/50	0.0
7/19/68	5 mi N Junction Stakes 35, 36, 37	11	51	0/50	0.0
7/19/68	6 mi N Junction Stakes 35, 36, 37	11	52	0/50	0.0
7/19/68	7 mi N Junction Stakes 35, 36, 37	11	53	0/50	0.0
7/19/68	7 mi N, 1 mi E Junction - Stakes 35, 36, 37	12	53	0/50	0.0
7/19/68	7 mi N, 2 mi E Junction - Stakes 35, 36, 37	13	53	0/50	0.0
7/19/68	7 mi N, 3 mi E Junction - Stakes 35, 36, 37	14	53	0/50	0.0
7/19/68	7 mi N, 4 mi E Junction - Stakes 35, 36, 37	15	53	0/50	0.0
7/19/68	7 mi N, 5 mi E Junction - Stakes 35, 36, 37	16	53	0/50	0.0

APPENDIX A

TABLE A-3

PARTICLE SIZES AND LOCATION
EP-IV

SAMPLE NO.	AZIMUTH FROM TEST CELL C (°True)	DISTANCE FROM TEST CELL C (mi)	SIZE* (μ)
400**	40	16.5	83x85, 25.4x25.4, several flakes (10-20 μ)
401***	43	16	Lost
402**	43	16	25.4x24.2, 43x35
403****	50	15	Lost (on rock)
404	54.5	15	20.5x31 (25.2)
405	59	14.5	24.8x19.5, 200x165.5
406**	59	14.5	54.2x59.5, 22.5x19, 21x27.2, 15x15
407	66	14	41x42.7 (41.8)
408	66	14	33x32, 33x35, 34x21
409	66	14	121x150, 22.5x19.5
410	66	14	8x9 (8.5)
411	74	14.5	42.5x43, 48.4x44
412	74	14.5	40x42 (41)
413	76	14.5	30x22, 48x48
414	87	14.5	48x71.5 (58.5)
415	49	21.5	50x45, 66x36
416	49	21.5	26x24.6 (25.3)
417	63	22	53.5x53.5 (53.5)
418	49	39	44.7x41 (42.8)
419****	52	38.5	21x18.5, several on rock
420	65	38	82.4x94.3 (88.1)

*The number in ( ) is the equivalent diameter
**Shattered in Radioautographic (AR) process
***Lost from slide in AR process
****Couldn't remove from rock

APPENDIX A

TABLE A-4

SPECIAL SAMPLES*

SAMPLE NO.	SIZE (μ)
300	75x90
301	30x30
302	90x75
303	90x90
304	90x75
305	75x90
306	45x65
307	75x45
308	105x120
309	120x75
310	150x150
311	60x45
312	45x45
313	75x90
314	30x45
315	105x150
316	30x30
317	60x60
318	45x30

*Collected within 1 mile radius of CP-1

APPENDIX A

TABLE A-5

PARTICLE SIZES AND LOCATION
EP-V

SAMPLE NO.	AZIMUTH FROM TEST CELL C (°True)	DISTANCE FROM TEST CELL C (mi)	SIZE* (μ)
500A	3.5	14.5	100x51.7 (71.9)
500B	3.5	14.5	74.7x90 (82)
501	5.5	14.5	100x73 (85.4)
502	7.5	14.5	25x42 (32.4)
503	10	14.5	53.2x46.9 (50)
504	11.5	14	52x45 (48.4)
505	11.5	15	31.2x35 (33)
506	14	15	91x58 (72.6)
507	14	15	35.7x22.5 (28.3)
508	14	15	55.4x57.5 (56.4)
509	14	15	22.7x30.5 (26.3)
510A	14	15	38x23 (29.6)
510B	14	15	113x92.7 (102)
510C	14	15	43.2x25.6, 45.5x43
510D	14	15	91.5x83.8 (87.5)
511	15.5	15	39x35 (36.9)
512A	17	15.5	27x23 (24.9)
512B	17	15.5	43x88.9 (61.8)
512C	17	15.5	23.7x15.5 (19.2)
512D	17	15.5	15.7x16.6, 13.5x17.8
513A	17	15.5	33.5x31.6 (32.5)
513B	17	15.5	95x109, 17.5x17.5, 29x14
513C	17	15.5	37.5x45.7, 15x20, 14x15
513D	17	15.5	33.8x30, 14.4x19.8
514	17	15.5	39x34 (36.4)
515	18	16	47x44.5 (45.7)
518	19	16.5	30x25.5 (27.7)

*The number in ( ) is the equivalent diameter.

TABLE A-5 (cont)

SAMPLE NO.	AZIMUTH FROM TEST CELL C (°True)	DISTANCE FROM TEST CELL C (mi)	SIZE* (μ)
519A	19.5	17	11.5x11.5, 45.5x37.2
519B	19.5	17	94.8x88.2, 24.2x27.9
520	19.5	17	24x39.1 (30.6)
521	20	17.5	57.5x69 several ≈ 20μ
522	22	18	7.2x7.2, 22.2x25.9
523	22	18	124x136 (130)
524	22	18	Several 10-20μ Shell ripped
525	22	18	92x90 (91.5)
526	22	18	155x133 (144)
527	22	18	Large rock
528	25	18	41.2x59.6 (49.6)
529	25	18	35.1x29.5, 100x94.5
530	25	18	61.9x61.5, 118x131
531A	11	22.5	63.4x73.2, 9x12
531B	11	22.5	87.8x64, 16x14
531C	11	22.5	23.6x21.5, 13x12.4, 28.5x28.5, 24x18.5
532	13.5	23	56x51.6 (53.8)
533A	13.5	23.5	19.5x15.4, 15.5x15
533B	13.5	23.5	69x66 (67.4)
534	13.5	24	Large rock
535	13.5	24	42.5x58.4 (49.8)
536	13.5	24	18.4x13.9, 92.5x70.6, 153x163
537	14.5	25	Several 10-20μ flakes (shattered bead)
539	16	25	45.5x54.5 (49.8)
540	16	25	9.2x9.2 (9.2)
541	16	25	174x135 (153)
542A	16	25	13.7x12.6, 39.9x32.2
542B	16	25	63.4x67.4 (65.4)

TABLE A-5 (cont)

SAMPLE NO.	AZIMUTH FROM TEST CELL C (°True)	DISTANCE FROM TEST CELL C (mi)	SIZE* (μ)
543	17	25	38.5x49.7 (43.7)
544	17	25	143x82.5 (109)
545	17	25	15x15 (15)
546	17	25	80.1x65 (72.1)
547	18	25	34.5x37.1 (35.8)
548	19	25	73.5x73.5 (73.5)
549	19	25	36.1x34.3 (35.1)
550	21	25	109x115 (112)
551	21	25	60.5x68.5 (64.4)
552	21	25	131x115 (123)
553	22	24.5	69.6x66.2 (67.9)
554	23	24.5	86.4x78.2 (82.2)
555	23	24.5	59.5x65.4 (62.4)
556	24.5	24	28x28, 15x15, 15x10, 12.5x12.5, 30x30
557	24.5	24	100x62.5 (79.1)
558	25	24	41.8x25 (32.3)
559	26	24	123x60.5 (86.3)
560	27	23.5	143x80.4 (107)

APPENDIX A

TABLE A-6

ACTIVITY AND LOCATION OF SAMPLES
EP-IV

ARC (mi)	SAMPLE NO.	ACTIVITY*			AZIMUTH FROM TEST CELL C (° True)	DISTANCE FROM TEST CELL C (mi)
		FISSIONS ($x10^{10}$)	dpm ($x10^3$)	pCi ($x10^3$)		
15	400	14	1,400	640	40	16.5
15	401	5.6	570	260	43	16
15	402	9.9	1,000	450	43	16
15	403	0.6	60	27	50	15
15	404	0.8	77	35	54.5	15
15	405	1.6	170	75	59	14.5
15	406	0.2	20	9	59	14.5
15	407	0.2	20	9	66	14
15	408	4.2	430	190	66	14
15	409	19	2,000	900	66	14
15	410	0.02	2	0.7	66	14
15	411	0.006	0.6	0.3	74	14.5
15	412	2.2	230	100	74	14.5
15	413	2.1	220	98	76	14.5
15	414	1.0	97	44	87	14.5
25	415	0.9	91	41	49	21.5
25	416	1	97	44	49	21.5
25	417	2.4	240	110	63	22
40	418	0.5	49	22	49	39
40	419	1.5	156	70	52	38.5
40	420	2.9	300	130	65	38

*dpm and pCi at 7/9/68

APPENDIX A

TABLE A-7

ACTIVITY AND LOCATION OF SAMPLES
EP-V

ARC (mi)	SAMPLE NO.	ACTIVITY*			AZIMUTH FROM TEST CELL C (° True)	DISTANCE FROM TEST CELL C (mi)
		FISSIONS ($x10^{10}$)	dpm ($x10^3$)	pCi ($x10^3$)		
15	500A	2.6	600	270	3.5	14.5
15	500B	3.8	860	390		
15	501	2.9	660	300	5.5	14.5
15	502	0.5	110	48	7.5	14.5
15	503	1.2	270	120	10	14.5
15	504	6.3	1,400	650	11.5	15
15	505	6.1	1,400	620	11.5	15
15	506	2.4	540	240	14	15
15	507	1.2	270	120	14	15
15	508	2.0	453	200	14	15
15	509	0.9	220	97	14	15
15	510A	0.1	30	13	14	15
15	510B	1.2	280	130		
15	510C	0.7	160	72		
15	510D	1.8	410	180		
15	511	0.5	120	52	15.5	15
15	512A	0.3	76	34	17	15.5
15	512B	3.0	680	310		
15	512C	0.5	100	47		
15	512D	0.1	39	18		
15	513A	0.4	100	46	17	15.5
15	513B	4.3	980	440		
15	513C	0.6	130	60		
15	513D	2.5	560	250		
15	514	1.1	250	110	17	15.5
15	515	1.1	240	110	18	16
15	518	0.8	190	85	19	16.5

*dpm and pCi at 7/23/68

TABLE A-7 (cont)

ARC (mi)	SAMPLE NO.	ACTIVITY*			AZIMUTH FROM TEST CELL C (°True)	DISTANCE FROM TEST CELL C (mi)
		FISSIONS ($\times 10^{10}$)	dpm ($\times 10^{3}$)	pCi ($\times 10^{3}$)		
15	519A	0.6	133	60	19.5	17
15	519B	3.5	800	360		
15	520	0.4	84	38	19.5	17
15	521	15	3,500	1,600	20	17.5
15	522	0.3	62	28	22	18
15	523	0.4	94	42	22	18
15	524	7.7	1,700	790	22	18
15	525	2.0	450	200	22	18
15	526	9.5	2,200	970	22	18
15	527	2.1	480	210	22	18
15	528	1.4	330	150	25	18
15	529	3.2	730	330	25	18
15	530	9.4	2,100	960	25	18
25	531A	3.8	880	400	11	22.5
25	531B	7.4	1,700	760		
25	531C	1.2	280	130		
25	532	0.1	23	10	13.5	23
25	533A	1.1	260	120	13.5	23.5
25	533B	3.8	870	390	13.5	23.5
25	534	2.4	550	250	13.5	24
25	535	2.0	450	200	13.5	24
25	536	11	2,400	1,100	13.5	24
25	537	7.6	1,700	780	14.5	25
25	539	2.1	480	210	16	25
25	540	0.009	2	0.9	16	25
25	541	37	8,500	3,800	16	25
25	542A	0.1	23	10	16	25
25	542B	1.9	430	190		
25	543	2.5	560	250	17	25
25	544	0.01	23	10	17	25

TABLE A-7 (cont)

ARC (mi)	SAMPLE NO.	ACTIVITY*			AZIMUTH FROM TEST CELL C (°True)	DISTANCE FROM TEST CELL C (mi)
		FISSIONS ($\times 10^{10}$)	dpm ($\times 10^{3}$)	pCi ($\times 10^{3}$)		
25	545	0.4	93	42	17	25
25	546	0.2	55	25	17	25
25	547	1	220	99	18	25
25	548	1.9	430	190	19	25
25	549	1.2	270	120	19	25
25	550	2.8	630	290	21	25
25	551	3.2	730	330	21	25
25	552	19	4,400	2,000	21	25
25	553	3.5	790	360	22	24.5
25	554	1.0	230	100	23	24.5
25	555	0.5	110	48	23	24.5
25	556	3	690	310	24.5	24
25	557	0.3	78	35	24.5	24
25	558	1.4	330	150	25	24
25	559	1	220	100	26	24
25	560	20	4,500	2,000	27.5	23.5

APPENDIX A

TABLE A-8

ISOTOPIC ACTIVITIES
FOR INDIVIDUAL SPECIMENS* - EP-IV

pCi x10^3

ISOTOPE	^{95}Zr	^{140}Ba	^{141}Ce	^{147}Nd
SAMPLE NO.				
300	210	440	330	340
301	0.5	0.3	0.4	0.4
302	170	260	120	280
303	40	84	67	66
304	40	1.8	2.6	4.2
305	12	12	13	16
306	43	33	37	77
307	43	16	22	50
308	6	1.5	2.2	2.7
309	230	180	220	390
311	67	100	91	120
312	7.8	7.5	8.4	11
313	31	34	29	31
314	32	29	33	46
315	32	30	35	50
316	26	26	20	2[illegible]
317	20	11	11	23
318	10	2.9	4.5	12
319	19	16	19	29
320	36	59	58	60

*Activity at 1409, June 26, 1968.

APPENDIX A

TABLE A-9

ISOTOPIC ACTIVITIES FOR
INDIVIDUAL SPECIMENS* - EP-V

pCi x10^3

ISOTOPE**	^{91}Sr (100)	^{95}Zr (58)	^{97}Zr (100)	^{99}Mo (99)	^{103}Ru (45)	^{133}I (100)	^{135}I (100)	^{140}Ba (65)	^{141}Ce (47)	^{143}Ce (100)	^{239}Np (100)
SAMPLE NO.											
501	1,100	54	1,300	9	23	--***	3,600	42	40	650	700
502	270	10	310	4.4	3.2	-----	-----	7.4	11	140	76
504	2,400	130	870	24	61	-----	-----	200	140	1,300	1,200
505	2,600	160	1,700	60	93	440	-----	180	210	1,600	1,900
506	980	51	1,000	30	26	-----	5,500	69	80	590	610
507	530	21	540	9.3	9	73	-----	27	31	330	210
508	880	37	820	120	11	-----	5,000	29	35	430	400
509	360	13	420	5.5	6.9	-----	840	14	18	210	130
510A	50	2.3	41	6.3	1.4	-----	-----	1.5	1.9	30	26
510B	470	30	280	63	16	53	-----	21	23	280	310
510C	480	23	250	35	9.6	-----	-----	17	19	290	380
510D	54	30	470	4.7	11	-----	-----	25	26	310	390
511	300	13	400	2.9	2.9	-----	850	6.3	11	180	110
512A	220	7.5	300	7.3	5.4	-----	-----	5.9	6.5	93	77
513B	2,100	100	2,200	15	41	-----	6,400	68	74	1,300	1,200
513C	250	12	120	15	3.7	13	-----	9.1	7.8	150	120
513D	1,100	61	610	9.6	84	-----	-----	39	42	750	830
514	660	25	270	2.5	6.2	-----	-----	15	19	410	360
531A	1,100	74	1,500	6.2	32	-----	-----	72	89	680	720
531B	1,400	150	1,800	27	58	120	-----	140	190	1,800	1,600
531C	610	20	300	14	7.8	47	-----	23	28	260	210
539	880	42	580	13	12	-----	-----	30	49	500	260
543	1,500	57	300	20	21	-----	-----	64	58	670	700
548	750	35	170	14	10	-----	-----	31	43	330	270
552	6,500	250	1,600	62	100	-----	-----	320	470	4,100	2,800
553	1,000	61	240	3.9	22	-----	1,800	63	86	660	390

TABLE A-9 (cont)

ISOTOPE**	^{91}Sr (100)	^{95}Zr (58)	^{97}Zr (10)	^{99}Mo (99)	^{103}Ru (45)	^{133}I (100)	^{135}I (100)	^{140}Ba (65)	^{141}Ce (47)	^{143}Ce (100)	^{239}Np (100)
SAMPLE NO.											
556	1,300	58	1,100	21	41	370	-----	91	99	780	1,000
559	560	21	310	15	15	60	-----	38	37	320	250
560	580	390	36,000	28	190	1,700	-----	400	480	4,400	5,900

*Activity at 1608, July 18, 1968
**Percent of activity due to EP-V in ( )
***Not Present

APPENDIX A

TABLE A-10

MICROPROBE AND X-RAY DIFFRACTION DATA

SAMPLE NO.	RUN	PROBE ANALYSIS	DIFFRACTION ANALYSIS
404	EP-IV	----*	UO_2, U_2O_5
411	EP-IV	----*	UO_2, U_2O_5
417	EP-IV	U, O, Nb, C	U_2O_5
530	EP-V	U, O	UO_2, U_2O_5
550	EP-V	U, O	----**
D-1		U, O	UO_2, U_2O_5
D-2		U, O	UO_2, U_2O_5, UC_2

*Excess of latex covering particle.
**Sample had high activity causing darkening of X-ray film.

TABLE A-11

SIZE-FREQUENCY DISTRIBUTION EP-V

	GEOMETRIC MEAN DIAMETER	GEOMETRIC STANDARD DEVIATION
15 mi Arc	48.2	1.77
25 mi Arc	57	2.04

APPENDIX A

TABLE A-12

RATIOS OF FISSION PRODUCT ACTIVITIES BASED ON ^{99}Mo EP-V

SAMPLE NO.	^{91}Sr	^{95}Zr	^{97}Zr	^{99}Mo	^{103}Ru	^{133}I	^{135}I	^{140}Ba	^{141}Ce	^{143}Ce
501	120	6	140	1.0	2.6	----	400	4.7	4.4	72
502	61	2.3	70	1.0	0.7	----	----	1.7	2.5	3.2
504	100	5.4	36	1.0	2.5	----	----	8.3	5.8	54
505	4.3	2.7	28	1.0	1.6	7.3	----	3.0	3.5	27
506	33	0.9	33	1.0	0.9	----	180	2.3	2.7	20
507	57	2.3	58	1.0	1	7.8	----	2.9	3.3	35
508	7.3	0.3	6.8	1.0	0.1	----	42	0.2	0.3	3.6
509	65	2.4	76	1.0	1.3	----	150	1.8	3.3	38
510A	7.9	0.4	6.5	1.0	0.2	----	----	0.2	0.3	4.8
510B	7.5	0.5	4.4	1.0	0.2	0.8	----	0.3	0.4	4.4
510C	14	0.7	7.1	1.0	0.3	----	----	0.5	0.5	8.3
510D	11	6.4	100	1.0	2.3	----	----	5.3	5.5	66
511	100	4.5	140	1.0	1.0	----	290	2.2	3.8	62
512A	30	1.0	250	1.0	0.7	----	----	0.8	0.9	13
513B	140	6.7	150	1.0	2.7	----	430	4.5	4.9	87
513C	17	0.8	8.0	1.0	0.3	0.9	----	0.6	0.5	10
513D	130	7.1	71	1.0	9.8	----	----	4.5	4.9	87
514	260	10	110	1.0	2.5	----	----	6.0	7.6	160
531A	180	12	240	1.0	5.2	----	----	12	14	110
531B	52	5.6	67	1.0	2.1	4.4	----	5.2	7.0	67
531C	44	1.4	21	1.0	0.6	3.4	----	1.6	2.0	19
539	68	3.2	45	1.0	0.9	----	----	2.3	3.8	38
543	75	2.9	15	1.0	1.1	----	----	3.2	2.9	34
548	54	2.5	12	1.0	0.7	----	----	2.2	3.1	24
552	100	4.0	26	1.0	1.6	----	----	5.2	7.6	66
553	260	16	62	1.0	5.6	----	460	16	22	170
556	62	2.8	52	1.0	2.0	15	----	4.3	4.7	37
559	19	0.7	10	1.0	0.5	2.0	----	1.3	1.2	11
560	21	1.4	1,300	1.0	6.8	61	----	14	17	160
Bolles & Ballou	5.8	0.05	4.1	1.0	0.04	7.5	8.9	2.3	0.09	1.9

*Theoretical ratios for gross mixed fission products (5).

APPENDIX A

TABLE A-13

RATIO OF ACTUAL RATIOS (to ^{99}Mo) TO THEORETICAL RATIOS (to ^{99}Mo) FOR EACH ISOTOPE

SAMPLE NO.	^{91}Sr	^{95}Zr	^{97}Zr	^{99}Mo	^{103}Ru	^{133}I	^{135}I	^{140}Ba	^{141}Ce	^{143}Ce
501	20.6	120	34	1	65	---	45	2	49	37
502	10.5	46	17	1	18	---	--	0.7	28	2
504	17.2	110	9	1	63	---	--	4	64	28
505	0.7	54	7	1	40	1.0	--	1	39	14
506	5	18	8	1	23	---	20	1	30	11
507	9.8	46	14	1	25	1.0	--	1	37	18
508	1.2	6	2	1	3	---	5	0.1	3	2
509	11.2	48	19	1	33	---	17	0.8	37	20
510A	1.4	8	2	1	5	---	--	0.1	3	3
510B	1.3	10	1	1	5	0.1	--	0.1	4	2
510C	2.4	14	2	1	8	---	--	0.2	5	4
510D	1.9	130	24	1	58	---	--	2	61	35
511	17.2	90	34	1	25	---	33	0.9	42	33
512A	5.2	20	61	1	18	---	--	0.3	10	7
513B	24.1	130	37	1	68	---	48	2	54	46
513C	2.9	16	2	1	7.5	0.1	--	0.3	6	5
513D	22.4	140	17	1	250	---	--	2	54	46
514	44.8	200	27	1	63	---	--	3	84	84
531A	31.0	240	59	1	130	---	--	5	160	58
531B	8.9	110	16	1	53	0.6	--	2	78	35
531C	7.6	28	5	1	15	0.5	--	0.7	20	10
539	11.7	64	11	1	23	---	--	1	42	20
543	12.9	58	4	1	28	---	--	1	32	18
548	9.3	50	3	1	18	---	--	1	34	13
552	17.2	80	6	1	40	---	--	2	84	35
553	44.8	320	15	1	140	---	52	7	240	89
556	10.7	56	13	1	50	2	--	2	52	19
559	3.3	14	2	1	13	0.3	--	0.6	13	6
560	3.6	28	320	1	170	8.1	--	6	190	84